NATURE

Vol. 142 SATURDAY, AUGUST 20, 1938 No. 3590

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Editorial and Publishing Offices:

MACMILLAN & CO., LTD., ST. MARTIN'S STREET, LONDON, W.C.2.

Telephone Number: Whitehall 8831 Telegraphic Address: Phusis, Lesquare, London

The annual subscription rates are: £2 12 0 British Isles, £2 17 0 Foreign, payable in advance

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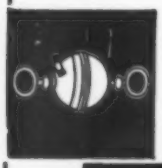

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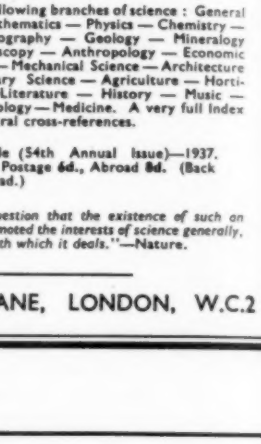

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Telegraphic Address:
PHUSIS, LESQUARE, LONDON

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Vol. 142 SATURDAY, AUGUST 20, 1938 No. 3590

The Significance of Vision for Scientific Progress

LORD RAYLEIGH'S presidential address to the British Association, which is printed in full in a Supplement to this issue of NATURE, is divided into two distinct parts under two titles. The first part, dealing with "Vision in Nature and Vision aided by Science", is a masterly general survey of developments in this field, which have taken place largely within the last two or three decades. In simple and direct language—itself a model of what such a survey should be—Lord Rayleigh describes the fundamental aspects of human vision and passes on to review the various ways in which the mechanism of the eye, employed as a means of observation, has been supplemented. The use of lenses, the telescope, the microscope, cathode rays, X-rays, spectroscopy and colour vision, photography and the sensitization of photographic plates, the photo-electric detection of radiation and television are all touched on, the salient features skilfully emphasized and the limitations and prospects of development duly noted. This part of Lord Rayleigh's address will surely bring home the vital fact that the largest part of our knowledge of Nature has been obtained by the sense of sight, and will remind us that progress by this means is not yet exhausted but bids fair, indeed, to go forward to fresh discoveries.

Very important parts of knowledge come, we remember, by the interpretation of images obtained by various optical devices with or without intermediate detection or recording. They are generally found as two-dimensional records of some object-field, although by kinematography and allied methods, and by stereoscopy, the senses of movement and three-dimensional extension can be obtained. But it is probably true that the newer technical methods, for example, the ultra-violet microscope, the iconoscope, and the like have not been exploited to a tithe of their possibilities by those who might use them to the greater advantage. The tendency of biological workers to use the microscope more as an automatic machine, and less as a research instrument, has been regretfully commented upon by those in a position to know the modern way. It is true that these methods are available, but they demand a certain training for use—a price which few are apparently willing to pay.

This is true in the extreme sense of the electron microscope, the invention which seems to open up a new world to more 'direct' observation. We are, as Lord Rayleigh remarks, very far from the perfecting of such instruments; those who expect them to be sold at a cheap rate in instrument-makers' shops, and to be operated by the laboratory boy, will be disappointed. It will be necessary to recapture the spirit of the early microscopists, for whom the labour of grinding their lenses was not too tedious to be faced, although the difficulties now encountered with high-vacuum technique and the design of electron-optical lenses are quite of another character and not less formidable even to the most sophisticated. The results obtained, especially in the microscopy of colloids, are extremely promising, and it seems almost certain that in some fields the method will far surpass anything possible to the optical microscope.

"Seeing is believing", no doubt, but it is interesting to speculate how far 'seeing' can go, when the worlds to which we would penetrate are so far out of reach of feeling and the other senses which help to make up our world of experience.

Social and International Relations of Science

THE widespread interest in the social relations to science, which in Great Britain is witnessed, for example, by the founding of the new Nuffield College at Oxford, and of the National Institute of Economics and Social Research, London, and elsewhere by the institution last year of the Committee on Science and its Social Relations by the International Council of Scientific Unions, and which has since received striking manifestation at the Indianopolis meeting of the American Association for the Advancement of Science, has largely been stimulated by the growing anarchy in the international sphere, whether economic or political. The threat to freedom of thought inherent in the totalitarian States, the existence of which is indeed only possible through the application of scientific knowledge, provides one of the main stimulants. The profound concern engendered everywhere by the increasing scale on which national energies and resources are being devoted to preparations for warfare, even to the detriment of standards of living, however, provides another source of such interest, both in the ranks of scientific workers themselves and in the population generally.

It is, accordingly, appropriate that a portion of Lord Rayleigh's presidential address to the British Association should be devoted specifically to the question of science and warfare. Although he makes no claim to offer a positive contribution to the subject, at least his remarks should assist to dispel some of those misconceptions which impede that full contact and co-operation between scientific workers and their fellow citizens which are essential to effective study or action.

A right conception of the position and responsibility of science is a fundamental condition, and Lord Rayleigh's remarks should make it clear beyond question that the discoveries of science which have been utilized in warfare were made in no nefarious quest, and were indeed often laid aside by scientific men as of no practical value.

Dismissing, therefore, the idea that scientific men are specially responsible for the application of fundamental discoveries of science to purposes of war, we can face the essential and wider problem of assisting a world anxious to accept the gift of science to make wiser use of the knowledge and powers which science can bring. Lord Rayleigh, accordingly, referred to the proposal for the establishment of a Division of the British Association to deal with the social and international relations of science.

The whole question has been dealt with very fully in NATURE in recent leading articles. The object of the suggested Division, which of course, like the various sections of the Association, would be responsible to the Council, would be to further the objective study of the social relations of science. The types of problems with which it might be called upon to deal would fall under the general headings of the effects of advances in science on the well-being of the community, and the effects of social conditions upon advances in science. The function of the committee organizing the Division would be to arrange meetings both at the annual meetings of the Association and elsewhere, to appoint speakers and to accept or reject communications. It would furnish material for the information of the public, co-ordinate work dealing with the social relations of science both at home and abroad, and be prepared to act in a consultative capacity, and to supply information. It would, accordingly, establish relations with organizations and persons engaged in practical administration, and set up sub-committees for executive purposes, or for research, inquiry or co-ordination.

If the Division is to make any significant contribution to the solution of these questions however, the committee will require the widespread and unwavering support of all scientific workers. Something more may be called for than the scientific investigation of social and international problems. A resolution of the American Association pointedly refers to the inroads being made upon intellectual freedom, and it should be unnecessary to emphasize that freedom of thought and discussion are essential if the new Division is to function effectively. Even if the organization of united action in that field falls outside the scope of the Division, it may at least serve to stimulate appropriate action or assist in bringing together professional associations both within and across national frontiers in defence of the most vital condition of the integrity and advancement of science itself.

It should be remembered indeed that this is a matter not so much of knowledge itself as of wisdom and values. The advancement of science demands

a certain immunity and tolerance to those engaged in scientific discovery and learning, and if the present threat to those liberties is to be resisted, scientific workers in their turn must recognize the normal conditions upon which such tolerance and immunity are accorded. Above all, they must be careful to maintain most scrupulously their intellectual honesty and independence of political pressure.

The wise use of science, however, involves especially questions of ethics and values, and is linked up inextricably with the general conditions and standards of the society in which scientific workers are placed. In all such questions the new Division would offer a hope of corporate action in bringing the serious spirit of science to bear in fields and on problems too often the sport of political prejudice, and might well provide another vantage ground from which scientific workers might make their fitting contribution to the solution of the problems of modern society.

Ferns and Fern Allies

Manual of Pteridology

Edited by Dr. Fr. Verdoorn, in collaboration with A. H. G. Alston, I. Andersson-Kottö, L. R. Atkinson, H. Burgeff, H. G. du Buy, C. Christensen, W. Döpp, W. M. Docters van Leeuwen, H. Gams, M. J. F. Gregor, M. Hirmer, R. E. Holttum, R. Kräusel, E. L. Nuernbergk, J. C. Schoute, J. Walton, K. Wetzel, S. Williams, H. Winkler and W. Zimmermann. Pp. xx+640. (The Hague: Martinus Nijhoff, 1938.) 24 guilders.

THE prodigious weight of this volume creates a desire for a light paper suitable for the reproduction of photographs. It contains twenty-three chapters, varying much in length, a few in German, most of them well documented and illustrated, written by twenty authors. The book is "primarily, but by no means exclusively, designed for the taxonomist who is anxious to improve his methods and broaden his outlook. At the same time it offers to the general botanist working on the Pteridophytes the necessary fundamental facts about the group and a survey of the chief results of lines of investigation related to his own".

As Prof. Bower says in the foreword, the ferns and their allies on one hand and the mosses and liverworts on the other hand appear to be separated by a wide gap; no living plants supply connecting links. He goes on to say that recently acquired knowledge of the oldest land-plants from Silurian and Devonian rocks has furnished some indication of possible transitional forms in the early stages of evolution. It is none the less true that the Bryophyta and Pteridophyta, including both extinct and recent genera, are two sharply contrasted groups. One may go farther and express the opinion that the study of ancient plants as a whole has been disappointing to searchers after missing links.

The first two chapters are by J. C. Schoute of Groningen, who contributes learned essays on morphology and anatomy which make severe demands upon the reader's power of concentration. In a concise historical introduction, Schoute pays a well-deserved tribute to the genius of Hofmeister, whose famous paper of 1851 had the effect of a 'flash of lightning'. We are reminded that Hofmeister expounded the theory of alternation of generations in three pages; he was master of a lost art! In an academic discussion of morphological conceptions, which contains much that is suggestive and provocative, due prominence is given to extinct types; the author's views on the stigmarian 'roots' of *Lepidodendron* and *Sigillaria*, and their comparison with the subterranean part of *Isoetes* (quillwort), will be regarded by some botanists as heterodox.

The chapter on anatomy is less satisfactory as an exposition likely to be informative and stimulating to taxonomists who wish to know more about the ancestors of plants which are their special concern. References to recent work on fossils are inadequate. One would like to have a clearly written essay on, for example, the anatomical structure of the arborescent lycopods and calamites of the forests of the Coal Age as contrasted with the much simpler construction of their living allies. This criticism is equally applicable to other chapters in the volume; authors, with few exceptions, seem to forget that they are supposed to address themselves to the general botanist. The chapter by S. Williams of Glasgow gives a well balanced and readable account of experimental morphology as an aid to the better understanding of form, development, and evolution. He adopts Prof. Lang's view that the individual development to adult structure is "the manifestation of the properties of the specific substance under certain conditions", and stresses the importance of more intensive research into the physico-chemical problems raised by the work of

Went and others on plant hormones. After quoting the dictum, "experiment cannot reconstruct history", Williams adds, with refreshing optimism: "if, however, palæobotanical data and the results of comparative morphology are taken in conjunction with the data derived from experiment, then it may be found that the latter will form a useful contribution to a probable solution of evolutionary problems".

Mary J. F. Gregor of Edinburgh gives a survey of work on associations with fungi and other lower plants; the section on the fossil record is meagre; on the other hand, diseases of both generations in ferns and other Pteridophytes receive thorough treatment. Prof. Burgeff of Würzburg contributes a valuable essay on mycorhiza including a particularly full account, with some admirable photographs, of the association of fungal mycelia with the prothalli of *Lycopodium*. This chapter will be of great use to teachers and advanced students. A short chapter by W. M. Docters van Leeuwen is devoted to galls caused by mites and insects. Cytology, exclusive of the nucleus, is dealt with by Lenette Rogers Atkinson of Amherst. It is questionable whether a subject such as cytology can be usefully treated from the restricted point of view necessitated by the scope of this manual. This doubt is also suggested after perusal of the chapter entitled "Karyologie" by W. Döpp of Marburg. It is pointed out that the high chromosome numbers and small size of the nuclei in some genera add greatly to the difficulty of investigating nuclear phenomena within the Pteridophyta. It may be, that despite lack of agreement in the nuclei of closely allied plants, additional information on nuclei and chromosomes will throw fresh light on natural affinity. I. Andersson-Kottö's chapter on genetics, which might have been written in less technical language, gives an interesting account of the comparatively small amount of genetical analysis so far undertaken, and directs attention to the promising lines of research presented by fern hybrids and facilitated by the relatively high degree of development of the sexual generation.

Growth and tropisms are discussed by H. G. du Buy of America and E. L. Nuernbergk of Freiburg: the influence of light on the development of prothalli, including the specific influence of different wave-lengths, is one of many subjects briefly treated. There is an interesting section on the physiological peculiarities of spermatozoids. Karl Wetzel of Berlin contributes a chapter on "Chemie und Stoffwechsel" which is a storehouse of facts useful as a source of information for botanists having a knowledge of biochemistry. There are two chapters on the ecology of Pteridophyta: one on extra-tropical members of the group by H. Gams of Innsbruck and the other by R. E. Holttum, director of the Singapore Garden. Both contain much that is of general interest; Dr. Gams, like many ecologists, forgets that the ordinary botanist is not thoroughly familiar with the superabundant terminology of the subject. Mr. Holttum has successfully accomplished the task of digging out references to the ecology of tropical ferns from general papers and has written a very readable and well-illustrated account mainly based on his own researches and observations in Malaya. The geography of Pteridophytes was entrusted to Hubert Winkler of Breslau who gives a good account of a fascinating subject. His table of distribution is a little difficult to interpret. Max Hirmer of Munich contributes a well-informed and useful survey of the distribution of fossil Pteridophyta in space and in time; like some other palæobotanists, he is a believer in continental drift.

Prof. J. Walton of Glasgow and A. H. G. Alston of the British Museum give a concisely written and welcome classification of the Lycopodinæ, both fossil and recent. R. Kräusel of Frankfort writes with authority on the Psilophytinæ, a group of Silurian and Devonian plants which makes a special appeal to the ingenuity of botanists in search of origins and clues to phylogeny. Chapters xviii and xix by Max Hirmer give concise and valuable descriptions of the two living genera of the Psilotinæ, *Psilotum* and *Tmesipteris*, and of the Articulatæ, including the single recent genus *Equisetum* and many extinct genera. His account of the latter, though good, makes one wish that he had written an essay which would enable botanists to appreciate the difference between the Palæozoic articulate plants and the solitary living representative of the group.

Carl Christensen of Copenhagen provides a classification of the Filicinæ which is a noteworthy contribution towards a natural system. Fossil ferns and Pteridophyta *Incertæ sedis* are briefly treated by Max Hirmer: there is some overlapping in this as in other chapters between different authors and discrepancies in views that are unavoidable. Prof. W. Zimmermann of Tübingen, in the final chapter, which is by no means easy reading, states his views on phylogeny. The Pteridophyta, with their long history and abundant remains preserved in rocks from the Devonian period onwards, would seem to offer an exceptionally rich harvest to students of evolution; but on the whole they are disappointing. Some of the oldest genera differ too widely from any living types to throw much light on the early stages of evolution; others, from Mesozoic rocks, differ only in minor characters from genera that are still with us. The chapter contains much that is

speculative, much that is stimulating; and yet as one reads it the question recurs: Do we estimate too highly the value of these efforts of the imagination as guides to the course of evolution?

The "Manual of Pteridology" is well printed and several of the comparatively few illustrations are excellent. Its chief value is as a book of reference for teachers and advanced students. Considered from the point of view of the editor, as stated in the introduction, it might have been made more generally useful had authors presented the results of recent research and adumbrated future lines of advance in a more readable, less condensed and less technical form. With few exceptions, the editor's description of the book as a collection of essays is scarcely appropriate.

Such criticism as the reviewer has made is not inconsistent with an expression of gratitude to the editor for this the latest of many services generously rendered to botanical science. Dr. Verdoorn, with the help of a company of experts, has produced a volume, representing a high standard of achievement, which will be heartily welcomed by his co-workers and admirers in many countries.

ALBERT C. SEWARD.

The Problem of Time

Time:
and its Importance in Modern Thought. By M. F. Cleugh. Pp. x+308. (London: Methuen and Co., Ltd., 1937.) 12*s*. 6*d*. net.

THIS stimulating and useful book, to which Prof. L. S. Stebbing contributes a short foreword, serves a double purpose: first, it puts before the reader, in comprehensive and concise form, the problems connected with the conception or experience or whatever we prefer to call it, of time; and secondly, it attempts to contribute something towards their solution. The fundamental importance of these problems is now fairly generally realized, and it is with some surprise that we learn from Miss Cleugh how recently this realization has come. As a consequence, books such as this, dealing with the general subject, are very few in number, and a new one therefore calls for some attention.

After an introductory statement, Miss Cleugh analyses the problem of time into its psychological, physical, logical and metaphysical elements, and each is critically discussed. The last-named receives by far the greatest amount of attention, and the views of Kant, Bergson, Alexander, McTaggart and Dunne are separately dealt with. A "synthesis" follows, in which the relevance of time to prediction, irreversibility, "becoming", contingency and reality is examined, and the author gives her own conclusions (if that is the right word) on the subject. The book is completed by a valuable bibliography which, as well as the text, bears testimony to the extent of the field surveyed.

Miss Cleugh has a happy gift of expression and often makes a subtle point clear by a terse sentence, but she tends to discount the effect of this quality by rather involved presentations of extended arguments. In the campaign to penetrate the reader's understanding she excels in tactics rather than in strategy. There are too many 'firstlys', 'secondlys' . . . within 'firstlys', 'secondlys' . . . to make the book easy reading, and a skeleton plan of each argument would have been helpful. It is not the confusion of the thought, but that of the presentation, which is chiefly open to criticism, and the reader who makes the necessary effort can grasp the meaning without ambiguity. This is so rare a characteristic of philosophical books that it seems ungrateful to ask for more; but since what is lacking could have been so easily supplied, it is impossible not to regret its absence.

Readers of NATURE will be chiefly interested in the physical aspect of time, and this unfortunately is the aspect which is least satisfactorily treated. Some important points are well put, but Miss Cleugh has certain misconceptions which are so common among philosophical writers on physics (and from which some physicists also are not entirely free) that it is well to point them out. She believes that we have "a primitive and direct perception of equality" of intervals. Perhaps so; but when she goes on to say that "it is on this that the whole of our measurement is based" (p. 40), she is definitely wrong. Our measurement is based on the readings of our chosen instruments, our direct perception entering only into the observation of *coincidences*, not intervals. If the clock contradicts our "primitive perception", we take the word of the clock; and indeed, it is an essential feature of relativity theory that we may choose a clock which grossly violates our intuitive notion of equality and our measurements will still be perfectly legitimate.

Another common misconception is that, in physics, velocity "involves duration before it can be comprehended" (p. 45). This is not so; we speak of velocity *at an instant*, and the phrase has

meaning. We can measure this velocity by an instantaneous observation of a Doppler effect, that is, of a colour; we do not need to make two observations separated by a duration. Again, in her discussion of simultaneity, Miss Cleugh tries to reconcile the plain man to Einstein's apparent absurdities by saying that Einstein means by simultaneity something different from the ordinary notion. But this will not do: in so far as the ordinary man has a direct knowledge of simultaneity, Einstein means what he does. The point is that the plain man's direct knowledge of simultaneity is confined to events which he actually experiences, and Einstein gives unambiguous meaning not only to the simultaneity of such events, but also to that of all events occurring at *any* one place. Events the simultaneity of which is ambiguous are among those which occur at different places, and of these the plain man must learn to understand that his supposed intuitive knowledge is prejudice.

Finally, Miss Cleugh criticizes the Fitzgerald-Lorentz contraction as an explanation of the Michelson-Morley experiment on the ground that "there is no obvious reason *why* we should assume that our measurements of time are accurate, and that our measurements of space are at fault, since the latter is much easier to measure" (p. 53). This criticism arises from a false idea of the experiment, derived from the popular account in terms of the times of travel of the two light beams. But this is purely metaphorical: time does not enter explicitly into the experiment at all. What was looked for, and was not observed, was a displacement of interference fringes, and the system of time measurement, conventionally chosen, would merely have determined the magnitude to be assigned to the earth's velocity if the displacement had been observed. Space measurement was important because the rods in the apparatus had to be equally long; but there was no clock in the apparatus, so that whatever motion did to time made no difference.

These points, however, are more relevant to the understanding of physics than to that of time, and their significance in relation to Miss Cleugh's work must not be magnified. Her main concern is with the metaphysical status of time, and our general feeling, after surveying the variety of discussion which she puts before us, is that much labour might have been spared if metaphysicians had taken a hint from science and approached their problems from the point of view of experience. "If I were to attempt to answer in a single sentence the question, 'What is time?'," writes Miss Cleugh (p. 280), "the answer would be, 'The alogical element in the universe'"; her point being that time is inseparably associated with change, and logic can deal only with what does not change. Now this will scarcely do. If time is the alogical element in the universe, then the logical elements must be outside time and therefore beyond our knowledge. The achievements of science show that that is not so. But why drag the universe into the question at all? Time is concerned with our experience; time is that which immediately removes experiences into the past, where they are inaccessible to change and therefore, on Miss Cleugh's own principle, may be amenable to logic. If, then, we begin with experience, we can use our reason freely. Problems concerning the future take on a different aspect, for the future is not experience, though it may possibly be anticipated by reason acting on static past experience. From this point of view we can make intelligible problems which, from the metaphysical point of view, are involved in contradictions.

Nevertheless, it is not wise wholly to ignore the labours of great thinkers, even when we feel that they are wrestling with chimeras. Miss Cleugh has given us a valuable conspectus of efforts, great and small, to reach the heart of the most fundamental of intellectual problems, and men of science as well as philosophers will be thankful for what she has done.

HERBERT DINGLE.

Greek Reptiles

Die Amphibien und Reptilien Griechenlands. Von Prof. Dr. Franz Werner. (Zoologica: Original-Abhandlungen aus dem Gesamtgebiete der Zoologie, Herausgegeben von R. Hesse, Heft 94.) Pp. iv+117+18 plates. (Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung, 1938.) 62 gold marks.

SINCE the old days of Sibthorpe and of the Expédition de la Morée, the study of the Greek fauna and flora has fallen more and more into German hands. Erhard, Krüper, Lindermayer and Otto Reiser have told us wellnigh all we know of bird-life in modern Greece, and now, following on the fifty-year-old work of Bedriaga, we have from Dr. Franz Werner an account of the many Greek amphibia and reptiles. The more we learn of the Greek fauna the more thankful we may be. Its varied ecology has many interesting facts and problems for the zoologist. The mountains have a mid-European fauna, the plains are 'Mediterranean', and the Peloponnese is typically 'Greek';

the islands differ notably from one another, and the Asiatic or Anatolian fauna begins in Rhodes and Cos and the rest of the Dodecanese. The classical student longs to know more about the several species, their folk-lore, their vernacular names, and all that may elucidate the ancient writers. Now Dr. Werner has given us a good, but it must be confessed a dry account, with many photographs and drawings, of the abundant Greek fauna of frogs and toads, tortoises, lizards and snakes. He is a good zoologist; but he very seldom quotes a Greek name, he cares nothing at all for Aristotle, he does not touch on the many ill-identified reptiles mentioned by Nicander in his "Theriaca". Nevertheless his book is of no small interest even to the classical student.

There are many poisonous snakes round about the Mediterranean, but in Greece there seem to be only two—*Vipera ammodytes*, widely distributed, and *V. lebetina*, confined to the western Cyclades. The Greeks, who are very poor naturalists, are often little aware of how poisonous these vipers are, while they look with superstitious fear on certain harmless toads and snakes and lizards, and show them no mercy. Some of the snakes are very large, as indeed Nicander tells us. *Coelopeltis lacertina* (here called by another name) grows two yards long; while among the fierce but harmless species of *Coluber* (or *Zamenis*) the long slender *C. najidum*, the σαίττα of the Greeks, common in Attica, and the rarer *C. jugularis*, may grow even to three yards long. Of 'Greek' tortoises, favourites of the traveller, there are three species, besides two water-tortoises, *Emys* and *Clemmys caspica*; it is the latter which is the common ἁ χελῶνα τοῦ ποταμοῦ. The chameleon, well known to Aristotle, is not found on the mainland of Greece, but only in Chios, Samos, Crete and Asia Minor; the salamander, on the other hand, common in Greece, is absent from all the islands of the Archipelago. The large lizard *Tropidosaurus algira*, commonly said to occur in Greece, is not mentioned by Dr. Werner, and there are some other notions current about the fauna which his book will help to correct or dispel.

The price of this small book, 62 gold marks, is quite unconscionable. D. W. T.

Crystal Physics

A Text-Book on Crystal Physics

By Dr. W. A. Wooster. Pp. xxii+295. (Cambridge: At the University Press, 1938.) 15*s*. net.

THIS book is stated to be intended for students at universities, and the reader is forewarned that for its proper understanding a knowledge of the elements of physics, mathematics and crystallography is necessary. A very considerable acquaintance with higher mathematics will certainly be required; indeed the book has a somewhat forbidding appearance, owing to being overladen with mathematical formulæ and Cartesian tensorial notation. The author obviously recognizes this, for certain chapters and many paragraphs are marked to be omitted at a first reading. That the first chapter should be so marked, however, is disconcerting, for it is supposed to explain the tensor notation employed throughout the book.

The author is not very generous, or even fair, to previous investigators. The fallacy is repeated that little was done in crystal physics previous to the discovery by Laue in 1912 of the X-ray diffraction by crystal planes, the work which paved the way being entirely ignored. For the most marvellous thing about the X-ray analysis of crystals is the clinching confirmation which it has brought of the conclusions, principles, and possible types of crystal structure, derived from the previous researches, besides its conversion of relative measures to absolute ones. Moreover, it is surely incorrect to say that "in particular there was an almost complete absence of researches on the variation of a given physical property in a large number of crystals having chemical or crystallographic similarities". The work of Perrot, Miers, Pope, Barker, von Groth (with his four magnificent volumes of related substances), Becke, Muthmann, Schoenflies, Barlow and Fedorov, and (in all humility) the reviewer, whose thirty years' work on the eighty Tutton salts, and fifteen related simple salts, is now being added to as regards their magnetics by Krishnan, are clear cases of work in the domain of crystal physics which appear to be ignored in the above-quoted statement.

Having said so much in diffident criticism, it must be added that there is a wealth of real value in the book. There are, especially, good chapters on thermal conduction and magnetic induction in crystals, on the piezo- and pyro-electric properties of crystals, and on their elastic and dielectric constants. The book is admirably printed in larger type than usual, but the illustrations are only line drawings, except two or three figures reproduced from other authors. It is appropriately dedicated to the late emeritus professor of mineralogy and master of Pembroke College, Cambridge, Prof. Arthur Hutchinson. A. E. H. T.

Plant Form and Function

By Prof. F. E. Fritsch and Prof. E. J. Salisbury. Pp. viii+668. (London: G. Bell and Sons, Ltd., 1938.) 17*s*. 6*d*. net.

STUDENTS and teachers of botany have in the past made good use of the two text-books by the joint authors: "An Introduction to the Study of Plants" and "An Introduction to the Structure and Reproduction of Plants". In the volume now under review the authors have, in response to many requests, united the subject-matter of both books into a single volume. This has been done successfully by dove-tailing the chapters of the two earlier books very ingeniously, so that the new volume forms a very harmonious whole, and its composite nature can only be ascertained by a careful comparison of the text with that of the component parts. The authors may therefore be congratulated on a clever piece of synthesis. The new volume will be appreciated even more than the two earlier text-books, for it gives a more complete as well as a consecutive account of the elementary features of botany and thus facilitates the study of the subject.

The authors have taken the opportunity also of bringing the subject-matter up to date. This is particularly apparent in the chapter on heredity and evolution, in which the more recent developments of cytology are dealt with and explained. In some of the physiological chapters new matter has been added, such as an account of the growth-promoting hormones. New discoveries in connexion with the alternation of generations in the Algæ, heterothallism in the Fungi and recent work on the cytology of the basidium are all dealt with in the new volume. Students will appreciate the fact that to each of the more important sections a selected list of books is given for further reference and also conveniently listed under that heading in the index.

More than a hundred new illustrations have been added. An additional chapter on the British flora as well as the inclusion of additional families in the taxonomic section is a welcome sign that the importance of systematic botany is regaining recognition.

Bacteriology:

a Text-Book of Micro-organisms. By Prof. Fred Wilbur Tanner. Third edition. Pp. xiii+510. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1937.) 17*s*. 6*d*. net.

THIS book, though by no means elementary, is designed for the use of those who are studying bacteriology for the first time. The student making use of it should possess some acquaintance with the elements of biology, and the book may then be considered as continuing his biological studies in the domain of micro-organisms, more particularly the bacterial forms, though chapters on the yeasts, moulds and Protozoa are also included. It deals especially with fundamentals, and particular attention is devoted to the structure, nutrition, metabolism and classification of the bacteria, and the action of physical agents upon them; this matter occupies the first half of the book. The second half is devoted to a consideration of the processes involving bacterial action, and chapters deal with the bacteriology of water and milk and canned foods, sewage disposal through bacterial action, and the various industrial fermentations dependent upon bacteria. Finally, the relation of bacteria to diseases, animal and plant, is considered, and the nature of immunity is briefly discussed.

The book gives an excellent survey of all the subjects with which it deals, it is very readable, and the biographical details included of the pioneers of the science increase the interest; it is also well illustrated. The only fault-finding we would register is that the author, in an appended bibliography, in many instances gives the date of old editions of text-books, when much later ones have appeared.

R. T. HEWLETT.

The Chemistry of Antigens and Antibodies

By J. R. Marrack. (Medical Research Council, Special Report Series No. 230.) Pp. 194. (London: H.M. Stationery Office, 1938.) 3*s*. net.

IN 1934, the Medical Research Council published, "for the assistance of workers in the field", a report on the chemistry of antigens and antibodies prepared by Prof. J. R. Marrack. The widespread interest in this report, not only of workers in the subject, but also of many others interested in biochemistry, has led to the decision to revise it in the light of discoveries made during the last four years, and the task has again been entrusted to Prof. Marrack.

The admirably wide view of the subject adopted by the author leads to the inclusion of a chapter on physico-chemical considerations, in which topics such as the electronic theory of valency and theories of the structure of proteins are discussed. To those engaged in the field of immunological chemistry, the two chapters on the nature of antigen-antibody reaction will be of particular interest, but to all those concerned in one aspect or another of the chemistry of biological phenomena, this report can be recommended as providing a lucid and comprehensive survey of a field which is, at present, expanding at an astonishing rate.

Mea Culpa:

and the Life and Work of Semmelweis. By Louis-Ferdinand Céline. Translated by Robert Allerton Parker. Pp. x+175. (London: George Allen and Unwin, Ltd., 1937.) 5*s*. net.

THIS little book consists of two unequal and unconnected portions. In the first, which occupies only 34 pages, the writer, who is a qualified medical man but is best known for his authorship of the unconscionably long and dreary novel entitled "Journey to the End of the Night", makes a frenzied attack on Communism as the result of a recent visit to Soviet Russia. The second part contains a lively and sympathetic account of the great Hungarian medical man, Ignaz Philip Semmelweis, who was a pioneer in the prophylaxis of puerperal fever in the pre-Listerian era, and died insane in 1841 at the age of forty-seven years after failing to convince his contemporaries of the truth of his doctrines.

Polarographic Research on Cancer

By Prof. J. Heyrovský, Charles University, Prague

IT is believed that an account of the scientific foundation and technical details of polarographic research on cancer, on which method of serological investigation three letters have recently appeared in NATURE[1,2,3], will be of general interest.

A dilute aqueous solution of blood or serum is studied polarographically, which means that a direct current is passed through it under increasing voltage in order to record the current-voltage curve. The cathode consists of mercury dropping slowly (every 3 seconds) from the mouth of a thick-walled capillary with a narrow bore (0·05–0·06 mm. diameter); the layer of mercury at the bottom of the beaker serves as the anode. A few cubic centimetres of the solution are sufficient for carrying out the electrolysis. The applied E.M.F. is increased from zero to about 2 volts whilst the current corresponding to the applied E.M.F. is registered photographically. The current-voltage curves which ensue in this arrangement are independent of the duration of electrolysis and may be repeated any number of times with great reproducibility, the current being determined by the voltage and the composition of the solution. The theory, the practical applications and necessary apparatus for this sort of electrolysis are the work of J. Heyrovský and his school.* The apparatus automatically recording current-voltage curves was called the polarograph[4], the resulting diagrams 'polarograms', and this branch of electrochemistry has been termed 'polarography'[5,6]. In the latest model of the recording apparatus, the galvanometer, shunt, potentiometric and photographic drum are all enclosed in one box, 'the micropolarograph', suitable for medical and technical applications.†

In 1930 a polarographic effect of proteins was described[7] which consisted of a characteristic 'wave' at the voltage of 1·6 on the current-voltage curve of a solution of ammonium chloride containing traces of proteins; this effect has been shown to be due to the electrolytic evolution of hydrogen catalysed by the presence of the protein at the cathode interphase.

Since then the protein effect has been investigated in the Physico-Chemical Institute of the Charles University by R. Brdička[8], who introduced a more specific polarographic reaction for the proteins by adding to the 0·1 *N* solutions of ammonium chloride and ammonia a solution of a cobaltous or cobaltic salt of about 0·001 *N*. He has shown that proteins containing sulphur cause in such solutions a new 'wave' at a smaller voltage (1·4) and ascribed this effect to the sulphydryl and di-sulphidic groups of the protein. This conclusion is supported by the fact that simple thio-acids, like thio-glycolic acid, cysteine or cysteyl-glycine or their di-sulphidic forms, produce a similar catalytic polarographic effect[9], but only in the presence of salts of divalent cobalt, whereas higher polypeptides and proteins give the effect also in the presence of salts of trivalent cobalt. With this very sensitive and reproducible reaction, Brdička was able to work out a micro-analytical estimation of cystine in one short piece of hair, follow the kinetics of hydrolysis of proteins and determine the proteolytic activity of pepsin[10]. In 1936 he became acquainted with the work of A. Purr and M. Russel[11], who found that carcinomatic blood shows in certain biological reactions less activity than normal blood. E. Waldschmidt-Leitz and his collaborators[12] attempted to use this reaction for cancer diagnosis and expressed the opinion that the lack of activity of the carcinomatic serum is due to decreased activity of the sulphydryl groups in the proteins of blood serum.

Brdička now tried his polarographic reaction, which gives the activity of the sulphydryl or di-sulphidic groups in the blood serum, to compare them in normal and carcinomatic serum. On direct comparison of the native sera, but little difference is shown. However, if denatured sera are compared, a distinctly lower polarographic protein effect in the pathologic sera is found. The denaturation may be effected by adding alkali to the serum and allowing it to stand at room temperature. Another way which also leads to considerable differences between normal and carcinomatic sera, is to add 0·2 c.c. of the serum to 5 c.c. of 0·05 *N* hydrochloric acid containing 5 mgm. of pepsin and to keep the mixture at 40° C. After half an hour, 0·2 c.c. of the mixture is withdrawn, added to the cobaltous 'Brdička solution' (0·1 *N* ammonium chloride, 0·1 *N* ammonia, 0·001 *N* cobaltous chloride) and the polarographic curve of this solution is registered (between 0·8 and 1·8 v.). In this manner the polarogram reproduced

*For bibliography see Collection of Czechoslovak Chemical Communications, **10**, 1938, p. 153–173. In the same journal most of the work appeared as "Polarographic Studies".

†The sole polarograph maker with whom the inventor collaborates is Dr. V. Nejedlý, Prague-XIX, Kladenská 76; in America these genuine polarographs may be obtained from E. H. Sargent & Company, 155 East Superior Street, Chicago.

as Fig. 1 was obtained. The denaturation or the peptic action liberates the disulphidic groups through a re-arrangement or cleavage of the micellar structure of the protein molecules, thus indicating that the carcinomatic serum contains fewer sulphur groups than the normal one. This conclusion was verified by the estimation of cystine in the hydrolysates of the normal and pathologic sera examined, when Brdička obtained the same differences—both polarographically and colorimetrically—in the content of cystine as were found by his protein test[2].

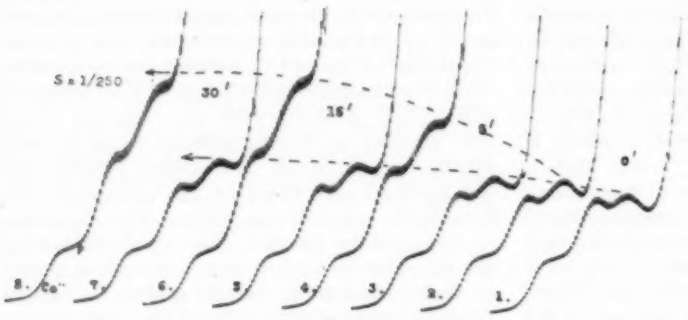

Fig. 1.

LIBERATION OF THE POLAROGRAPHICALLY ACTIVE GROUPS OF PROTEINS BY PEPTIC CLEAVAGE. CURVES 1, 3, 5, 7, WITH CARCINOMATIC SERUM, CURVES 2, 4, 6, 8 WITH NORMAL SERUM, IN COBALTOUS BRDIČKA'S SOLUTION. SENSITIVITY 1/250, VOLTAGE 0·8–1·8. CURVE 8: Co^{++} DENOTES THE COBALTOUS 'WAVE', P THE PROTEIN 'WAVE'. THE CURVES WERE RECORDED AFTER 5, 15 AND 30 MIN. OF THE REACTION.

Another significant reaction has been worked out by K. Mayer in collaboration with Brdička in the Physico-Chemical Institute of the Charles University, involving deproteination of the serum[12]. For this purpose 0·5 c.c. of serum is added to 1·0 c.c. of 0·1 *N* potassium hydroxide, and after standing one hour the proteins are precipitated by the addition of 1·5 c.c. 20 per cent sulphosalicylic acid; 0·5 c.c. of the filtrate is added to the cobaltic 'Brdička solution' (0·1 *N* ammonium chloride, 0·1 *N* ammonia, 0·001 *N* cobaltammine, $Co(NH_3)_6Cl_3$). In this manner the liquor is freed from proteins; however, their decomposition products—the albumoses—remain partially in solution. Investigations have shown that carcinomatic sera have a larger content of these products soluble in sulphosalicylic acid than normal sera. Consequently an abnormally high 'wave' obtained after deproteination (Fig. 2) indicates a pathological case, just as does the abnormally low 'wave' obtained after peptic cleavage (Fig. 3). The degradation of the protein molecules, which thus is shown to take place in the carcinomatic serum, may be effected artificially by treating a normal serum with alkali or pepsin, by which the products partly soluble in sulphosalicylic acid are split off and cause then the latter polarographic pathological effect.

The pathological state indicated by the abnormal height of Brdička's protein 'wave' has been ascertained to be due to carcinoma or sarcoma—if acute cases of inflammation or fever are eliminated. The serum in the latter pathological state gives with either reaction an abnormal, that is, a 'positive' effect. Investigations are now being directed towards distinguishing whether the decomposition products of the serum proteins due to cancer are different from those due to other diseases (inflammation, fever) so as to make the polarographic reaction in this respect more specific.

The first systematic research using the polarographic diagnosis of cancer was carried out by Brdička in collaboration with Dr. F. N. Novák, director of the Radio-Therapeutic Institute, Bulovka, Prague: from 187 cases, the polarographic diagnosis agreed in 102 out of 107 histologically ascertained carcinomatic cases, 11 of the 13 sarcoma cases, whilst one of the 38 normal sera showed a positive polarographic reaction; of the 29 non-carcinomatic diseases, 14 were polarographically positive and 15 negative.

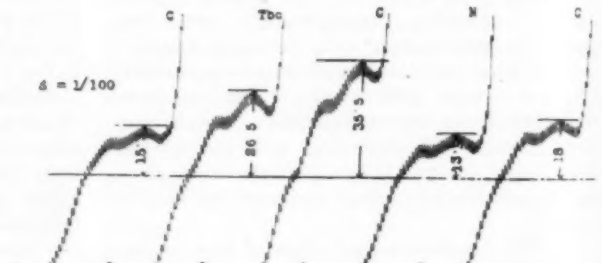

Fig. 2.

PATHOLOGICAL SERA COMPARED WITH NORMAL SERUM AFTER DEPROTEINATION. (1) CA PORTIONIS VAGINALIS. (2) FUNGUS GENUS SINITRI (TBC). (3) CA VENTRICULI. (4) NORMAL SERUM. (5) CA VENTRICULI.

A similar agreement was found in the Finsen Institute and Radium Station, Copenhagen[3], where amongst the positive reactions some cases of hepatic disorder were ascertained. The

polarographic cancer diagnosis is being successfully applied also in the Institute of Organic Chemistry (director, Prof. E. Waldschmidt-Leitz) and in the Gynæcological Clinic (director, Prof. H. Knaus), of the German University, Prague, and at several hospitals in Czechoslovakia and in Germany.

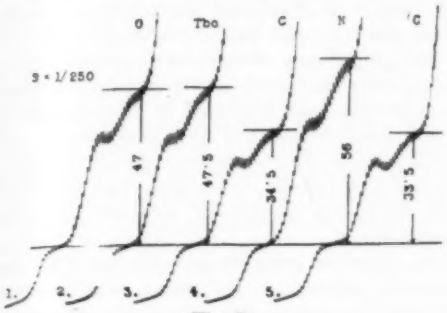

Fig. 3.

PATHOLOGICAL SERA COMPARED WITH NORMAL SERUM AFTER TREATMENT WITH PEPSIN. CURVES 1–5 REFER TO THE SAME CASES AS IN FIG. 2.

General experience shows that the first reaction (with pepsin) deviates the more from normal the more developed is the stage of cancer—increasing from 3 to 50 per cent. An attempt is being made to refine this polarographic diagnosis by experimenting on animals so as to distinguish an early stage of cancer. Whilst there are many details still to be investigated in the polarographic reaction of cancer, the diagnosis, just as it is presented here, offers already substantial advantages over biological tests. It is automatically registered and perfectly reproducible; the chemical treatment is very simple and comparatively short (one hour standing at room temperature); only 0·5 c.c. of serum is needed, but the reaction may even be carried out with one or two drops (0·1 c.c.) of blood.

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[2] Brdička, R., NATURE, **139**, 1020 (1937).
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[6] Heyrovský, J., "Practical Applications of the Polarographic Method in Chemistry" (in Czech) (Praha, 1933). Enlarged Russian Edition (Leningrad, 1937).
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[8] Brdička, R., Collection of Czechoslovak Chemical Communications, **5**, 112 (1933).
[9] Brdička, R., Collection of Czechoslovak Chemical Communications, **5**, 148 (1933); *Biochem. Z.*, **272**, 104 (1934).
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Excavations at Njoro, Kenya

By Dr. L. S. B. Leakey

DURING the latter part of April and the beginning of May, preliminary excavations were carried out at a small rock-shelter in the forest near Njoro, Kenya Colony, and as a result, a new branch of the local neolithic stone-bowl culture was discovered presenting certain interesting features. This small rock-shelter had been used during the neolithic period not as a living site but as a place for disposal of the dead by incineration, and the particular method which was used in burning the bodies resulted in the preservation of a number of objects not usually found in stone-age sites, owing to their perishable nature.

The method in which incineration was carried out was to dig a shallow hole in the floor of the shelter, place the body in this, in a contracted position, together with a variety of grave goods, cover the whole with soil and red ochre and then light a large fire on top. The result of this treatment was that the bodies were baked rather than burnt, while combustible objects such as baskets, cord, woodwork and even calabashes were preserved as charcoal instead of turning to ash.

As each successive body was brought to the site to be incinerated a fresh hole was dug into the charred remains of previous burnings which were then disturbed, and in course of time the deposit forming the floor of the shelter to a depth of about three feet became composed to a large extent of charcoal and burnt bone. Only the bones of the last few bodies incinerated in the shelter before it was abandoned were, therefore, reasonably intact, and the vast majority of the skulls and skeletons were much broken up.

Although only a very small part of the cave floor has been excavated, the site had been so extensively used that the remains of more than seventy individuals were recovered. Indeed, at one point, an area of one cubic yard contained the remains of sixteen individuals.

So far as can be stated at present, the human remains indicate that the population was very similar to that which I have described in the "Stone Age Races of Kenya" as the Elmenteitan type of man; but certain other elements appear to be present also.

The human remains, however, are by no means the most interesting of the discoveries at this site, and the chief interest centres around the charred basketry and woodwork and also the many stone beads which were found.

Three quite distinct types of basket work were recovered, as well as fragments of a narrow strip of finely woven string fabric which suggest a belt. All of these were preserved as charcoal dust, but treatment with 'Durofix' dissolved in amyl acetate proved to be a satisfactory preservative, and the charcoal dust was transformed into a fairly hard substance. Large quantities of plaited fibre string and cord were also recovered in the same way.

CARVED WOODEN VESSEL FROM NJORO, KENYA

A remarkably well-carved wooden drinking vessel was found, and this is shown in the accompanying illustration. Both the detail of the carving and the finish on the inside of the vessel suggest that it could scarcely have been made by neolithic man using only obsidian tools, and we are inclined to the belief that this vessel represents an object imported from one of the early civilizations.

While the evidence of the wooden vessel alone would be insufficient ground for postulating a trade with Kenya from one of the early civilizations, this idea is strongly supported by the stone beads. Some five hundred of these as well as a number of beautiful stone pendants were recovered, and they all exhibit a very high degree of workmanship. The semi-precious stones include fire-opals, carnelians, agates (banded and moss varieties) common opals, green quartz and Amazon stone (microcline-felspar). Of these, opals account for more than half the beads. The Amazon stone is of unusually fine quality and at first was mistaken for jade, to which it bears a superficial resemblance.

A variety of shapes of beads occur, including barrels and flat disks, the latter mainly of opal. In all cases the degree of skill shown in shaping and drilling the stone beads and the pendants contrasts strongly with that exhibited in the manufacture of the bone beads and pendants, which were certainly made by the neolithic people concerned, and this again seems to suggest that the former were made by people of superior skill and knowledge.

This view is strengthened by the fact that extensive prehistoric opal mines are connected with this site and in the surrounding area; it is difficult to believe that they were the work of neolithic man for the sake of his personal adornment without a stimulus from outside.

On the evidence at present available, therefore, we incline to the view that there was influence from one of the early civilizations which initiated the mining for opals. It is even possible that there was direct contact with the traders, who employed as labour the neolithic inhabitants of the district and paid for the labour with stone beads and pendants.

Besides the articles described above, the site yielded a very large number of stone bowls and pestles of a type quite distinct from those belonging to the other branches of the local stone-bowl culture complex, a number of flat grindstones and rubbers, some pottery and also some obsidian implements. No trace of metal was found.

It is impossible at present to give a precise date to these new discoveries, but certain indications, such as the method of disposal of the dead, the physical type represented by the skulls and the nature of the obsidian tools all give a definite link with the Elmenteitan mesolithic culture. On the other hand, the stone bowls and pestles are definitely related to those found with other variants of the stone-bowl culture, but they are somewhat cruder typologically.

These facts seem to suggest a date intermediate between the mesolithic and the other neolithic industries previously discovered, and a *very tentative date* of *circa* 4000–3000 B.C. is therefore suggested.

Much will depend on whether the stone beads and pendants and the carved wooden vessel can be definitely linked with any of the early civilizations of the Near East or elsewhere. Any evidence which readers of NATURE can offer bearing on the subject would be greatly appreciated.

Obituary Notices

Dr. A. E. H. Tutton, F.R.S.

ALFRED EDWIN HOWARD TUTTON, who died on July 14, was born on August 22, 1864, at Cheadle Moseley, now the Edgeley district of the borough of Stockport. He attended science classes at the Stockport Mechanics Institute and also the evening courses in chemistry of Prof. Roscoe at Owens College, Manchester. In 1883 he went to the Normal School of Science (later the Royal College of Science) and Royal School of Mines, South Kensington, with an exhibition, which he took in preference to a scholarship which he had gained for Owens College. During his period as a student, Huxley was professor of biology, Frankland of chemistry, Guthrie of physics, Judd of geology and Lockyer of astronomy, and a fellow-student was H. G. Wells. Tutton was a brilliant student and gained several scholarships and prizes. In the meantime, Thorpe had succeeded Frankland as professor of chemistry, and under his direction Tutton began the research on the lower oxides of phosphorus in which the new oxide P_2O_4 was discovered and the lower oxide P_4O_6 was first prepared in a state of purity and definitely characterized in its properties. This work was published in 1890 and 1891. In 1889, Tutton had been appointed to the post of demonstrator in chemistry and lecturer in chemical analysis at the College. During this period, he also assisted Thorpe and Rücker in the magnetic surveys of Scotland and England.

On the completion of this work, Tutton turned his attention to crystallography, taking some lessons in crystal measurement from Mr. H. A. (now Sir Henry) Miers, who was then assistant to Prof. Story Maskelyne at the British Museum (Natural History). He measured some organic compounds, including aconitine, which had been prepared in the laboratories, but his ambitions were of much wider scope in this subject. He formed a definite plan of research which was to occupy him for forty years, namely, the study of the crystal forms of chemically related series of compounds. These results, he saw, would throw light on the structure of salts, since by replacing one element in a crystalline salt by another, closely related, element, the effects on the molecular volumes and crystal angles of salts which had been generally regarded as isomorphous would be disclosed. It had early been recognized by Wollaston and by Mitscherlich that isomorphism was not absolute, and that small yet definite alterations in crystal angles resulted from the replacement of one isomorphous element by another.

The first series studied by Tutton comprised the sulphates and selenates of potassium, rubidium, cæsium, ammonium and thallium. This was followed by the double sulphates and selenates of these metals with those of magnesium, zinc, iron, nickel, cobalt, manganese, copper and cadmium, which form magnificent crystals with six molecules of water. In all, ninety-one salts were studied, and the results communicated in about fifty papers from 1890 until 1929. As a result of this painstaking and accurate work, it was established that the crystallographic properties vary regularly with the atomic weights of the interchangeable elements. The same result was established for the perchlorates and double chromates of the alkalis. This work could be brought into relation with the structures as revealed by the X-rays when this new method became available. In carrying out his crystallographic investigations Tutton showed the greatest ingenuity in devising and perfecting the measuring instruments, so that his methods became well known as representing the highest standard of crystallographic research.

In 1895 Tutton became an inspector of technical schools and moved to Oxford, where he equipped a private laboratory. In his ten years in Oxford he became associated with New College and took the B.Sc., D.Sc. and M.A. degrees, and in 1899 he was elected a fellow of the Royal Society. In Oxford he married Miss Margaret Loat. In 1905 he was transferred to the London district and moved his home and laboratory to London. He wrote some important books during this period, his "Crystalline Structure and Chemical Constitution" being published in 1910, "Crystals" in 1911, and "Crystallography and Practical Crystal Measurement" in 1911. The last work, which gives detailed accounts of his practical methods and instruments, appeared in a second edition in two volumes in 1922, and it constitutes one of the most valuable works on experimental crystallography in any language. His instruments, he recognized, could be applied to a comparison of the parliamentary and local government copies of the standard of length with the Imperial Standard Yard, and Tutton devised and supervised the construction of an interferential comparator for the Standards Department, the work being carried out in 1907–9. Further work in this direction was curtailed by his transfer to the south-western district centred on Plymouth, where he resided at Yelverton, on Dartmoor. His crystallographic researches were continued, although his laboratory was not now so convenient. In 1912 he became president of the Mineralogical Society. During the Great War he carried out special work for the Government.

Tutton's services as a lecturer were much sought and he delivered many courses, illustrated by demonstrations with his magnificent apparatus. He visited Canada with the British Association in 1909 and spent some time in climbing the Rocky Mountains. He also made many visits to the Alps, and in 1927 he published "A Natural History of Ice and Snow, Illustrated from the Alps", enriched by his own photographs. In 1929 he visited Cape Town with the British Association, also going to other parts of

Africa, and returning by way of Egypt and Palestine, which he visited.

In 1930 Tutton had resumed his work on the evaluation of the Imperial Yard in terms of the wave-lengths of light. The value, published in 1931 (his last paper), was 1,420,210 wave-lengths of the red radiation of cadmium in the yard at 62° F. The value published in 1934 by the National Physical Laboratory, who had used the Fabry-Perot method, was 1,420,209.

In 1924, Tutton moved his house and laboratory to Cambridge, where he participated in the university course in mineralogy at the invitation of Profs. Lewis and Hutchinson. His laboratory during this period was at its best.

Tutton entered into his retirement in 1931, his instruments being transferred to the Physics Department at the University of Manchester, which had conferred on him the honorary degree of D.Sc. in 1926.

Tutton's work stands as an enduring contribution to chemistry and crystallography. Marked by great accuracy and beauty of finish, it was achieved during a life conscientiously devoted to official duties, and hence it exhibits that peculiarly British character which is seen in the researches of other distinguished men of science who have laboured in like circumstances.

J. R. PARTINGTON.

Dr. C.-E. Guillaume

BY the recent death of Dr. Charles-Edouard Guillaume the world is deprived of a distinguished man of science who had taken a leading part in the advancement of the subject which, for more than fifty years, he had made his own.

His grandfather, Charles-Frederic-Alexandre Guillaume, leaving France for political reasons, lived for a time in England, where he established a watch-making business, carried on afterwards by his three sons, of whom Edouard eventually returned to settle at Fleurier, in the Swiss Jura, where Charles-Edouard was born on February 15, 1861.

In the course of his education, at the Gymnase in Neuchâtel, and at the Zurich Polytechnic, Guillaume showed a definite bent towards physics and, on leaving, became for a short time an artillery officer, devoting himself with enthusiasm to the study of mechanics and ballistics. So early as 1883, however, he entered the then recently established Bureau International des Poids et Mesures, at Sèvres near Paris, where he was destined to carry out his life's work. Commencing under the successive direction of O.-J. Broch and J. R. Benoît, he himself became director of the Bureau in 1915, a position which he held until his retirement, after fifty-three years' service, with the title of honorary director, in 1936.

Guillaume's earliest investigations were concerned with thermometry, an ever-important subject in the science of metrology, and particularly so in the early days of the Bureau, when the new standard metre was being established. Guillaume carried out important investigations on the corrections to mercury-in-glass thermometers, and himself made detailed calibrations of thermometers used at the Bureau in the establishment of the thermal expansions of the standards of length, and for other cognate purposes. He also shared in the initial intercomparisons of the platinum-iridium copies of the International Metre which were prepared for distribution to the various countries subscribing to the Convention du Mètre, and undertook a redetermination of the mass of the cubic decimetre of water, by the method of contact, which gave a result in such excellent agreement with that found by interferential measurements by Chappuis, and by Benoît and Buisson, that it has never been thought necessary since to repeat this measurement.

Guillaume's most important contribution, however, to the science of metrology in particular, and also to industry, was his investigation of the remarkable properties of the nickel-iron alloys. A chance observation, during a search for a suitable alloy, less expensive than platinum-iridium, to serve as a material for the construction of secondary standards of length, showed that one nickel-iron alloy had a coefficient of thermal expansion above, and another appreciably below, that of either iron or nickel separately. Guillaume at once decided on a systematic investigation of a whole series of alloys, which immediately revealed the general features of the system. Painstaking and exhaustive researches followed, in which he was fortunate to obtain the co-operation of M. Henry Fayol, who put at his disposal the resources of the Aciéries d'Imphy, for the preparation of samples. There resulted the discovery of 'invar', an alloy with very low (in some cases zero or even slightly negative) coefficient of expansion; 'elinvar', in which the thermal coefficients of linear expansion and elasticity are balanced so as to give constant period of vibration; together with other useful alloys. A complete theory followed of the reversible transformations on which the peculiar properties of these alloys depend.

The introduction of invar rendered practicable the procedure suggested by Jäderin for the use of wires instead of length bars in the measurement of geodetic bases, thus leading to the establishment of the rapid methods in current use for this purpose, and incidentally directly justifying the faith of geodesists by whose insistence largely the Convention du Mètre was originally brought into being. Invar has also been used widely in instrument making and for industrial purposes, for example, for thermostats. In addition, the use both of invar for the pendulums of astronomical clocks and of the 'Guillaume' integral balance with elinvar hair spring, which eliminates secondary errors in high-grade watches and chronometers, has led to a marked advance in the horological industry with which his family was traditionally associated. It is estimated that more than a hundred million watches with 'Guillaume' balances are now in existence.

Throughout his long career, Guillaume was an ardent propagandist for the metric system, and never lost an opportunity for furthering the extension of its application. As director of the Bureau International he had naturally to give much of his time to administrative affairs, and those who had the privilege of meeting and working with him received an impression

of outstanding courtesy, tact and charm. In addition to other honours and decorations from all over the world, too numerous to mention, he was a Grand Officer of the Legion of Honour, and in 1920 was awarded the Nobel Prize for Physics for his work on the nickel-iron alloys.

We regret to announce the following deaths:

Dr. Jan Constantijn Costerus, formerly director of the first High School at Amsterdam, Holland, known for his work on plant teratology, partly with Dr. J. J. Smith, on July 31, aged eighty-nine years.

Prof. Jacob Kunz, professor of mathematical physics in the University of Illinois, known for his work in astrophysics, on July 18, aged sixty-four years.

Prof. Earl B. McKinley, dean of the Medical School, director of medical research and professor of bacteriology in the George Washington University, on July 28, aged forty-three years.

Mr. F. C. Meier, plant pathologist of the U.S. Department of Agriculture, known for his work on the disease of economic fruits, and on ærobiology, on July 28, aged forty-five years.

Prof. Nicola Parravano, professor of general chemistry in the University of Rome, aged fifty-five years.

News and Views

Canadian Tour by Prof. C. D. Ellis, F.R.S.

Prof. C. D. Ellis, who holds the Wheatstone chair of physics at King's College, London, has been granted leave of absence for the Michaelmas and Lent terms in order to visit all the Canadian universities. The tour has been arranged by the Conference of Canadian Universities. The central idea of the scheme is that he should be able to spend some time, up to a week or ten days, in most of the universities, and have ample opportunity for meeting the staff and discussing matters of interest. While some formal lectures will be given, it is intended to restrict such to the minimum. By adopting this somewhat unusual but enlightened scheme, the Committee of the Conference of Canadian Universities is showing a very real appreciation of the problems involved in scientific co-operation. A formal lecture, followed by a rapid tour of the laboratories, gives no opportunity of knowing the workers and appreciating their researches. With the more extended visits which Prof. Ellis will be able to make, he will have an opportunity of taking a proper share in stimulating discussion. Prof. Ellis is leaving England in September, and will go first to Vancouver, and will visit Edmonton, Saskatoon, Winnipeg, Ottawa and Montreal before Christmas. Starting again in January, he will visit Hamilton, London, Toronto, Kingston, Quebec, Sackville, Halifax, returning to England at the end of March.

Dr. J. E. Myers, O.B.E.

Dr. J. E. Myers has been appointed principal of the Manchester College of Technology. He was educated at the Manchester Grammar School and at the University of Manchester, where he graduated with first-class honours in chemistry in 1910. Since that date, he has been continuously associated with University teaching and administration as lecturer in chemistry, secretary and tutor to the faculty of science and, more recently, assistant to the vice-chancellor in addition. He has represented the University on numerous bodies connected with higher education, and has been specially interested in student relations, graduate appointments, and the work of the Joint Matriculation Board. He obtained the D.Sc. degree in 1917, and two years later was awarded the distinction of O.B.E. in recognition of scientific work carried out for the Government during the Great War.

Robert Warington, F.R.S. (1838–1907)

On August 22 occurs the centenary of the birth of the English agricultural chemist, Robert Warington, who for many years worked at Rothamsted, Harpenden, Herts, and, like his contemporaries, Sir John Lawes and Sir Joseph Gilbert, is buried at Harpenden. Warington was the son of Robert Warington (1807–67) the practical chemist who convened the meeting at the Royal Society of Arts on February 23, 1841, which led to the formation of the Chemical Society. At this time, Warington's parents were living at the Apothecaries Hall, in the City of London, and as a boy he learned chemistry from his father and from the lectures of Faraday, Brande and Hofmann. When twenty years of age, he worked under Lawes at Rothamsted as an unpaid assistant; but a year later he returned to London as assistant to Frankland at South Kensington, whence he went to the Royal Agricultural College, Cirencester. It was here that he commenced lecturing on the Rothamsted experiments. Leaving Cirencester in 1867, he became chemist to Lawes's manure and acid factory at Millwall, but in 1876 returned to Harpenden, where he remained until 1891, publishing many memoirs on the nitrification of the soil. Leaving the Rothamsted laboratory, he lectured in America, and after his return home was examiner in agriculture to the Science and Art Department and Sibthorpian professor of rural economy at Oxford, a post he held for three years. He died at Harpenden on March 20, 1907. His most successful work was his "Chemistry of the Farm", which was translated into several foreign languages and reached its nineteenth edition while he was still alive.

The Problem of Political Refugees

THE conference which opened at Evian on July 6 to discuss the plight of German and Austrian refugees was watched by a great body of opinion in Great Britain in which scientific workers are well represented. A letter welcoming the initiative of the Government of the United States in this matter which was sent to President Roosevelt on May 31 bore the signatures of many eminent men of science among other leaders of intellectual life. The letter urged that co-operation should make it possible to facilitate the transfer of refugees to those countries where their abilities can find most scope, and to provide funds to enable them to make a fresh start, and urged the British Government to play its part both administratively and financially in the support of the great traditions of liberty, tolerance and humanity which it has in common with the United States. A further letter to the chairman of the conference urged the importance of immediate, constructive and practical decisions alike on religious, humane and economic grounds if the great democracies are to retain their ancient traditions of freedom and the right of asylum.

WHILE none who have welcomed the conference are blind to the difficulties of the situation, even in regard to the admission of skilled professional men and women, still more in what may be called the police problem, the actual outcome of the conference was somewhat disappointing. The establishment of a permanent international committee of which, at its first meeting on August 3, when twenty-seven countries were represented, Lord Winterton was elected chairman, indicates that within a limited field efforts are being and will continue to be made to deal with this grave problem. The committee has prominent American representation, and since it is not a League of Nations organization, it should be easier for it to get in direct touch with all countries responsible for the main refugee problem. Moreover, the term 'refugee' has been extended to include persons who, though they may not yet actually have left Germany or Austria, feel obliged to quit those countries as soon as they can because of persecution due to political opinions, religious beliefs, or racial origin. While, too, the question of settlement is financial as well as territorial, the democracies have every reason, from their own self-interest as well as that of justice, to support the international committee in any steps it may initiate to bring pressure to bear on the expelling countries to release at least a proportion of the refugees' property to assist in their re-establishment elsewhere.

Restoration of the Hurlers, Cornwall

FURTHER work of restoration on the Hurlers, the stone circles near Minions, Cornwall, has been carried out during the past four weeks on behalf of the Office of Works under the supervision of Mr. R. Ralegh Radford, director of the British School of Archæology at Rome. These circles have been under the guardianship of, and owned by the Office of Works since 1935, when certain preliminary work of investigation and restoration of the central circle was undertaken. According to a statement made by Mr. Radford (*The Times*, August 12) the recent investigations have been directed to the examination of the northern circle. Four stones, additional to the previously known twelve, were found under modern tip heaps, and will be re-erected in the original sockets. Missing stones will be indicated, as in the central circle, by low stumps inserted in the original positions. The damage to the interior of the northern circle by mining test-holes and digging will be repaired by filling and levelling. A floor of granite fragments similar to that discovered in 1935, washed out of the surface soil, has been discovered covering the greater part of the interior of the circle. Its thickness is less than that of the previously discovered floor, this possibility, it is suggested, being due to it having remained in use for a longer period. An interesting feature now brought to light is a rough pavement between the northern and central circles, and running along their common axis. This pavement is about six feet wide but does not reach out to both circles. The suggestion of a ceremonial purpose will, no doubt, be elucidated when examination is completed before the close of the season's work. Flint implements, more numerous than in 1935, include several types characteristic of the early metal age, with some of an earlier period. Work will be continued in 1939, when it is hoped to restore the monument to its original appearance, so far as that is possible. It is also intended to explore the neighbouring barrow, in which the Rillaton gold cup, now in the British Museum, was found. This has never been explored scientifically.

Roman Dorchester

FURTHER finds of interest are reported from Colliton Park and neighbouring land at Dorchester, where Roman buildings, it will be remembered, have been found on the site which is being prepared for the erection of a county hall. The Dorset Archæological Society, which has been responsible for supervising the work in the interests of archæology and for examining finds on the site, has recently made a cutting in Colliton Walk, adjoining the Park, which has brought to light part of the massive walls which once defended the Roman town. The walls, it is stated (*The Times*, August 12), were ten feet thick and of solid masonry. The ashlar facing has been removed, but the rubble core of flint and limestone, well mortared, still remains. The original wall was at least twenty feet high and was banked up internally by a large rampart, on the top of which was a walk for the sentries. It is hoped that further investigation may bring to light the foundations of the towers which were a feature of such fortifications. The walls at this point were destroyed a hundred years ago, when the walks were laid out; but enough has now been found to show the nature of the original construction. In the Park itself, where the site is now in the hands of the contractors, some further remains have been found. Among these is a water conduit, one of the open distributing channels of the Roman system of water supply. It is at the bottom

of a V-shaped cutting ten feet deep. The channel itself is four feet wide, with a bottom of red earthenware tiles. No conduit of this type had previously been found in this part of Roman Britain. It appears to have gone out of use in the second century A.D. The foundations of the three-roomed Roman building have now been cleared, and show the remarkable and unusually wide doorway, which is seven feet across.

Prehistoric Civilization of Northern France

THE party of archæologists deputed by the Society of Antiquaries of London to carry out archæological investigations in northern France is now at work in Brittany and western Normandy under the direction of Dr. R. E. Mortimer Wheeler. The expedition has been undertaken with the good will of, and under a permit from the French authorities, in accordance with an agreement into which the Society of Antiquaries entered with them last year. This investigation will constitute the major undertaking for the time being of the Society in archæological research in the field, taking the place of the excavation of Maiden Castle, Dorchester, upon which it was engaged, with Dr. Wheeler as its director, for some years. The purpose of the investigation in France is to search for evidence of the cross-channel origin of the civilization of south-western Britain in the later prehistoric period, and more especially of the fortified towns which appear there suddenly in a state of mature development, but of which the source is uncertain. This is a department of investigation in France which French archæologists have left virtually untouched. The programme of the investigators is in the first place to map the distribution of pre-Roman earthworks of the Maiden Castle type in north-western France, and secondly to ascertain by trial excavation on selected sites what cultures went to make up these Continental works. The first centre which has been chosen for excavation is Huelgoat, a well-known site in the pine forest about twenty miles south of Morlaix, where a camp nearly a mile in length is under examination. It is seen to have been built in the first century B.C. on the eve of the Roman conquest of northern France. The rampart, fifteen feet high, is faced with stone and bonded with lacing timbers. The ditch is in part cut out of the granite rock. The search for other sites has progressed so far as to show that the great Wessex fortified sites did not originate in Finistère, though certain smaller fortified enclosures in that department can be paralleled in Cornwall. Investigation will shortly move farther east to a large camp in the neighbourhood of Avranches.

Fungus Diseases of Animals

A NEW journal devoted to the fungus diseases of man and other animals has recently commenced publication (*Mycopathologia*, Den Haag, Dr. W. Junk, 18 Dutch florins per volume, 1, Fasc. 1, 80 pp. May 1938). The publication is international; it is edited in Italy and printed in Holland; the United States provides the first number with several authors, whilst the list of collaborators is long and geographically extensive. R. Ciferri, director of the Botanical Laboratory of the Faculty of Agriculture in the University of Florence, and P. Redaelli, director of the Institute of Pathological Anatomy in the University of Padua, are the joint editors. They contribute the first paper on "A New Hypothesis on the Nature of *Blastocystis*". This organism shows more affinities with certain algæ than with sporogenous yeasts, and the general biologist will welcome the discovery of a further link between fungi and algæ. Classification of fungi belonging to the genus *Actinomyces* is considered by E. Baldacci of Padua. The rest of the papers in the present number demonstrate the wide scope and outlook of the journal. The papers are all scientific contributions to a little-known section of mycology, and a "Bibliographia Mycopathologia" of references to work published in 1937 adds further utility. The production is excellent, both of type and plates, and the volume should supply a particularly welcome quota of knowledge in Great Britain, where fungal diseases of man are apparently not common enough to provoke research on a large scale.

Advances in Printing Telegraph Technique

IT is shown in a paper by A. E. Thompson, published in *Electrical Communication* of April, that at no period in the history of the telegraph has there been such revolutionary improvements in methods and equipment or such rapid development and expansion in its service to the community as during the last ten years. The progress was initiated by the introduction of teleprinter systems, which by providing instruments requiring no telegraphic skill on the part of the operators have completely changed the outlook of telegraphy and greatly stimulated development in all its branches. Teleprinters are superseding all the older types of machine telegraphic apparatus. Even hand Morse working, which has been the backbone of telegraphy for more than a century, has now been abandoned in the British telegraph service, the bulk of the traffic being handled by Creed teleprinters. Similar developments are taking place in other countries. A description is given of the new Creed No. 10 tape teleprinter. The improvements achieved are trustworthy service at 85 words per minute, reduced costs, quiet operation and reduced size. Maintenance costs have been reduced by evolving mechanisms with a breakdown speed exceeding 100 words per minute. The printer operates continuously for 300 hours without requiring lubrication. Ball-bearings and oil-impregnated bearings as well as sliding surfaces lubricated by means of oil reservoirs are used. This machine can be used by telegraph administrations and private companies as well as by high-speed news and ticker services.

History of Maize-Breeding

IN a recent lecture given at the Michigan State College, Mr. Henry A. Wallace, the United States Secretary of Agriculture, traced the history of maize or corn breeding and pointed out that up to 1890 the farmers of the corn-belt had not been superior to their Indian predecessors as corn breeders, the chief

improvement having been in substituting a later type of maize for the earlier ones grown by the Indians (Spragg Memorial Lectures on Plant Breeding. Eighth Annual Lecture: "Corn Breeding Experience and its probable eventual Effect on the Technique of Live-stock Breeding". By Henry A. Wallace. Pp. 6. East Lansing, Mich.: Michigan State College). The application of the genetic methods of Shull and East, that is, inbreeding of strains followed by cross-breeding of particular types, has since greatly increased the yield. In 1938, probably at least fifteen million acres will be planted, yielding 100 million bushels more than if ordinary open-pollinated types were used. It is suggested that similar methods applied to animal breeding (that is, homozygosis followed by controlled heterosis), first to egg production in fowls, then to swine, sheep, dairy cows and finally to beef cattle can produce similar results, and the methods of swine breeding in Denmark are cited. Mr. Wallace concludes that in mankind compulsory sterilization and selection of types under a dictatorship will not bring about the desired eugenic improvement in the human race. A standardized preconception of the perfect man, after the Nazi ideal of an Aryan 'race', is a false eugenic idea which will lead, in the long run, to the failure of eugenic progress.

Mexican Pictographic Manuscript

A DOCUMENT of extreme interest to students of American pre-Columbian history and culture, the Mendoza Codex, now in the Bodleian Library, has been reproduced in facsimile by Mr. J. Cooper Clark, Captain T. A. Joyce providing a foreword. The Mendoza Codex is one of several pictographic manuscripts which have survived. It was prepared by the authority of Don Antonio de Mendoza, who was appointed the first viceroy of New Spain in 1535. The Codex—or rather collection of codices, for there are three—consists of seventy-one folio pages, the pictographs being in colour. The first part is a copy of an old Mexican chronicle, now lost, of the history year by year of the Lords of Tenochtitlan, now Mexico City, and a list of the towns they conquered. It covers from A.D. 1325 until the fall of the Empire in 1521. The second part is a carefully executed copy of the tribute roll to Motecuçuma, the Mexican ruler, by upwards of four hundred towns. The original from which this is copied is now in the National Museum of Mexico, and consists of fourteen folios painted on maguey leaves. The third part of the Mendoza Codex is a compilation by the scribe for Mendoza's use, recording the life of a Mexican from day to day from the cradle to the grave. Although some of the pictures were included by Lord Kingsborough in his book on Mexican art a hundred years ago, this valuable manuscript has never before been reproduced in accurate facsimile as a whole. It has now been printed for private publication by Messrs. Waterlow on hand-made Whatman paper, the pictographs being beautifully reproduced in colour. There are three volumes, of which the first contains Mr. Cooper Clark's translation of the Spanish text with commentary, the second the interpretation of the Nahuatl place-name glyphs, now for the first time rendered in English, and the third volume is the facsimile in colour of the manuscripts. The subscription price of the three volumes is twenty guineas.

Very Low Temperatures

THE issue by the Science Museum of Books 2 and 3, describing the exhibits and outlining the lectures delivered at the special exhibition devoted to this subject in the Science Museum from March until June last year, completes the account of the exhibition. The three books have been edited by Mr. T. C. Crawhall, with the assistance of Dr. O. Kantorowicz for Book 2. The first book, issued at 6*d*., gives a survey of physical principles and some applications; the second, issued at 2*s*., deals with the apparatus exhibited for temperature reduction, temperature and pressure measurement, liquefaction and solidification of gases, the properties of the products, their storage and their applications. Included in the methods of cooling is that of demagnetizing a paramagnetic material. The third book, issued at 1*s*. 3*d*., gives accounts of the development of low-temperature technique, by Prof. M. Travers, the industrial uses of low temperatures, by Messrs. C. G. Bainbridge, J. T. Randall and I. J. Faulkner respectively, and the approach to the absolute zero, by Dr. J. D. Cockroft, Prof. F. Lindeman and Prof. F. Simon respectively. The three books constitute a valuable record of the present position of a subject which promises to have many applications in industry.

Crocodilian Energy

IMPERIAL AIRWAYS inform us that at the end of July, while one of their pilots was taking off in a flying boat at Port Bell on Lake Victoria, a crocodile gave a remarkable display of agility. The flying-boat had just taken to the air when, about forty yards away, a crocodile about nine feet long leapt full length out of the water, clearing the surface with its whole body by about four feet. Apart from its natural history interest, the occurrence was unusual, since, before a flying-boat takes off, the surrounding water is most carefully patrolled to guard against possible obstacles, and the flying-boats operate as far as possible from areas known to be haunted by crocodiles. This unusual air leap of the crocodile is analogous to the leaping of salmon and other fishes, for propulsion is due in both cases to the powerful movements of the tail muscles. The size of the individual, a young individual of a species *Crocodilus niloticus*, which may exceed twenty feet in length, illustrates a characteristic of many animals, that the young are notably more nimble than adults.

Recent Minor Earthquakes

AFTER the first series of shocks between July 5 and 9 (see NATURE of July 30, p. 203), in which buildings were badly cracked in Paliad and Botad though no lives were lost, further tremors have been recorded, and it was reported from Bombay on July 28 that all but the very poorest of inhabitants had deserted the town of Paliad. It is rare to find a

(*Continued on p.* 351)

NATURE

SUPPLEMENT

No. 3590 SATURDAY, AUGUST 20, 1938 Vol. 142

Part I

VISION IN NATURE AND VISION AIDED BY SCIENCE

Part II

SCIENCE AND WARFARE

by

The Right Hon. Lord Rayleigh, F.R.S.

President of the British Association*

Part I

THE last occasion that the British Association met at Cambridge was in 1904, under the presidency of my revered relative, Lord Balfour, who at the time actually held the position of Prime Minister. That a Prime Minister should find it possible to undertake this additional burthen brings home to us how much the pace has quickened in national activities, and, I may add, anxieties, between that time and this.

Lord Balfour in his introductory remarks recalled the large share which Cambridge had had in the development of physics from the time of Newton down to that of J. J. Thomson and the scientific school centred in the Cavendish Laboratory, "whose physical speculations," he said, "bid fair to render the closing year of the old century and the opening ones of the new as notable as the greatest which have preceded them." It is a great pleasure to me, as I am sure it is to all of you, that my old master is with us here as he was on that occasion. I can say in his presence that the lapse of time has not failed to justify Lord Balfour's words. What was then an intelligent anticipation is now a historical fact.

I wish I could proceed on an equally cheerful note. The reputation of the scientific school in the Cavendish Laboratory has been more than sustained in the interval under the leadership of one whose friendly presence we all miss to-night. The death of Ernest Rutherford leaves a blank which we can never hope to see entirely filled in our day. We know that the whole scientific world joins with us in mourning his loss.

Lord Balfour's address was devoted to topics which had long been of profound interest to him. He was one of the first to compare the world picture drawn by science and the world picture drawn by the crude application of the senses, and he emphasized the contrast between them. A quotation from his address will serve as an appropriate text to introduce the point of view which I wish to develop.

"So far," he said, "as natural science can tell us, every quality or sense or intellect which does not help us to fight, to eat, and to bring up our children, is but a by-product of the qualities which do. Our organs of sense perception were not given us for purposes of research . . . either because too direct a vision of physical reality was a hindrance, not a help in the struggle for existence . . . or because with so imperfect a material as living tissue no better result could be attained."

* Presidential address delivered at Cambridge on August 17.

Some of those who learn the results of modern science from a point of view of general or philosophical interest come away, I believe, with the impression that what the senses tell us about the external world is shown to be altogether misleading. They learn, for example, that the apparent space-filling quality of the objects called solid or liquid is a delusion, and that the volume of space occupied is held to be very small compared with that which remains vacant in between. This is in such violent contrast with what direct observation seems to show that they believe they are asked to give up the general position that what we learn from our senses must be our main guide in studying the nature of things.

Now this is in complete contrast with the point of view of the experimental philosopher. He knows very well that in his work he does and must trust in the last resort almost entirely to what can be seen, and that his knowledge of the external world is based upon it : and I do not think that even the metaphysician claims that we can learn much in any other way. It is true that the conclusions of modern science seem at first sight to be very far removed from what our senses tell us. But on the whole the tendency of progress is to bring the more remote conclusions within the province of direct observation, even when at first sight they appeared to be hopelessly beyond it.

For example, at the time of Lord Balfour's address, some who were regarded as leaders of scientific thought still urged that the conception of atoms was not to be taken literally. We now count the atoms by direct methods. We see the electrometer needle give a kick and we say, "There goes an atom." Or we see the path of an individual atom marked out by a cloud track and we see where it was abruptly bent by a violent collision with another atom.

Again, the theory of radioactive decomposition put forward by Rutherford, however cogent it may have seemed, and did seem to those who were well acquainted with the evidence, was originally based on indirect inferences about quantities of matter far too small to be weighed on the most delicate balance. Chemists were naturally inclined to feel some reserve ; but in due course the theory led to a conclusion which could be tested by methods in which they had confidence—the conclusion, namely, that lead contained in old uranium minerals ought to have a lower atomic weight than ordinary lead, and in all probability to be lighter, and on trying this out it proved to be so. More recently we have the discovery of heavy hydrogen with twice the density of ordinary hydrogen, and heavy water which is the source of it.

Lastly, the conclusion that ordinary matter is not really space-filling has been illustrated by the discovery that certain stars have a density which is a fabulous multiple of the density of terrestrial matter. Although this is in some sense a deduction as distinguished from an observation, yet the steps required in the deduction are elementary ones entirely within the domain of the older physics.

This and many other points of view have seemed at first sight to contradict the direct indication of our senses. But it was not really so. They were obtained and could only be obtained by sense indications rightly interpreted. As in the passage from Lord Balfour already quoted, the senses were not primarily developed for purposes of research, and we have in large measure to adapt them to that purpose by the use of artificial auxiliaries. The result of doing so is often to reveal a world which to the unaided senses seems paradoxical.

I have chosen for the main subject of this address a survey of some of the ways in which such adaptations have been made. I shall naturally try to interest you by dwelling most on aspects of the subject that have some novelty ; but apart from these there is much to be gleaned of historical interest, and when tempted I shall not hesitate to digress a little from methods and say something about results.

The Human Eye

I shall begin with a glance at the mechanism of the human eye, so far as it is understood. I shall show how the compromise and balance between different competing considerations which is seen in its design can be artificially modified for special purposes. All engineering designs are a matter of compromise. You cannot have everything. The unassisted eye has a field of view extending nearly over a hemisphere. It gives an indication very quickly, and allows comparatively rapid changes to be followed. It responds best to the wave-lengths actually most abundant in daylight or moonlight. This combination of qualities is ideal for what we believe to be Nature's primary purpose, that is for finding subsistence under primitive conditions, and for fighting the battle of life against natural enemies. But by sacrificing some

of these qualities, and in particular the large field of view, we can enhance others for purposes of research. We may modify the lens system by artificial additions over a wide range for examining the very distant or the very small. We can supplement and enormously enhance the power of colour discrimination which Nature has given us. By abandoning the use of the retina and substituting the photographic plate as an artificial retina, we can increase very largely the range of spectrum which can be utilized. This last extension has its special possibilities, particularly in the direction of using waves smaller than ordinary, even down to those which are associated with a moving electron. By using the photo-electric cell as another substitute for the retina, with electric wire instead of optic nerve and a recording galvanometer instead of the brain, we can make the impressions metrical and can record them on paper. We can count photons and other particulate forms of energy as well. We can explore the structure of atoms, examine the disintegration of radioactive bodies, and trace out the mutual relation of the elements. Indeed, by elaborating this train of thought a little further almost the whole range of observational science could be covered. But within the compass of an hour or so one must not be too ambitious. It is not my purpose to stray very far from what might, by a slight stretch of language, fall under the heading of extending the powers of the eye.

Most people who have a smattering of science now know the comparison of the eye with the camera obscura, or better, with the modern photographic camera—with its lens, iris, diaphragm, focusing adjustment and ground glass screen, the latter corresponding to the retina. The comparison does not go very far, for it does not enter upon how the message is conveyed to the brain and apprehended by the mind; or even upon the minor mystery of how colours are discriminated. Nevertheless, it would be a great mistake to suppose that the knowledge which is embodied in this comparison was easily arrived at. For example, many acute minds in antiquity thought that light originated in the eye rather than in the object viewed. Euclid in his optics perhaps used this as a mathematical fiction equivalent to the modern one of reversing the course of a ray, but other authors appealed to the apparent glow of animal eyes by lamplight, which shows that they took the theory quite literally. The Arabian author Alhazen had more correct ideas and he gave an anatomical description of the eye, but apparently regarded what we call the crystalline lens as the light-sensitive organ. Kepler was the first to take the modern view of the eye.

The detailed structure of the retina, and its connexion with the optic nerve, has required the highest skill of histologists in interpreting difficult and uncertain indications. The light-sensitive elements are of two kinds, the rods and cones. The rods seem to be the only ones used in night vision, and do not distinguish colours. The cones are most important in the centre of the field of view, where vision is most acute, and it seems to be fairly certain that in the foveal region each cone has its own individual nervous communication with the brain. On the other hand, there is not anything like room in the cross-section of the optic nerve to allow us to assign a different nerve fibre to each of the millions of rods. A single fibre probably has to serve two hundred of them.

The nervous impulse is believed to travel in the optic nerve as in any other nerve, but what happens to it when it arrives at the brain is a question for the investigators of a future generation.

Use of Lenses

The use of lenses is one of the greatest scientific discoveries: we do not know who made it. Indeed, the more closely we inquire into this question the vaguer it becomes. Spectacle lenses as we know them are a medieval invention, dating from about A.D. 1280. Whether they originated from some isolated thinker and experimenter of the type of Roger Bacon, or whether they were developed by the ingenuity of urban craftsmen, can scarcely be considered certain. There are several ways in which the suggestion might have arisen, but a glass bulb filled with water is the most likely. Indeed, considering that such bulbs were undoubtedly used as burning glasses in the ancient world, and that the use of them for reading small and difficult lettering is explicitly mentioned by Seneca, it seems rather strange that the next step was not taken in antiquity. Apparently the explanation is that the magnification was attributed to the nature of the water rather than to its shape. At all events, it may readily be verified that a 4- or 5-inch glass flask full of water, though not very convenient to handle, will give a long-sighted newspaper reader the same help that he could get from a monocle.

The invention of lenses was a necessary preliminary to the invention of the telescope, for, as Huygens remarked, it would require a superhuman genius to make the invention theoretically.

The retina of the eye on which the image is to be received has structure. We may compare the picture on the retina to a design embroidered in woolwork, which also has a structure. Clearly such a design cannot embody details which are smaller than the mesh of the canvas which is to carry the coloured stitches. The only way to get in more detail is to make the design, or rather such diminished part of it as the canvas can accommodate, on a larger scale. Similarly with the picture on the retina. The individual rods and cones correspond with the individual meshes of the canvas. If we want more detail of an object we must make the picture on the retina larger, with the necessary sacrifice of the field of view. If the object is distant we want for this a lens of longer focus instead of the eye lens. We cannot take the eye lens away, but, what amounts to nearly the same thing, we can neutralize it by a concave lens of equal power put right up to it, called the eyepiece. Then we are free to use a long focus lens called the telescopic objective to make a larger picture on the retina. It must, of course, be put at the proper distance out to make a distinct picture. This is a special case of the Galilean telescope which lends itself to simple description. It is of no use to make the picture larger if we lose definition in the process. The enlarged image must remain sharp enough to take advantage of the fine structure of the retinal screen that is to receive it. It will not be sharp enough unless we make the lens of greater diameter than the eye. Another reason for using a large lens is to avoid a loss of brightness.

It seems paradoxical that the image of a star should be smaller the larger the telescope. Nevertheless it is a necessary result of the wave character of light. We cannot see the true nature of, for example, a double star unless the two images are small enough not to overlap, and far enough apart to fall on separated elements of the observer's retina.

When the problem is to examine small objects, we look at them as close as we can: here the short-sighted observer has an advantage. By adding a lens in front of the eye lens to increase its power we can produce a kind of artificial short sight and get closer than we could otherwise, so that the picture on the retina is bigger. This is a simple microscope, and we can use it to examine the image produced by an objective lens; if this image is larger than the object under examination we call the whole arrangement a compound microscope.

Given perfect construction, there is no limit in theory to what a telescope can do in revealing distant worlds. It is only a question of making it large enough. On the other hand, there is a very definite limit to what the miscroscope used with, say, ordinary daylight can do. It is not that there is any difficulty in making it magnify as much as we like. This can be done, for example, by making the tube of the microscope longer. The trouble is that beyond a certain point magnification does no good. Many people find this a hard saying, but it must be remembered that a large image is not necessarily a good image. We are up against the same difficulty as before. A point on the object is necessarily spread out into a disk in the image, due to the coarseness of structure of light itself as indicated by its wave-length. I cannot go into the details, but it is well known that points on the object which are something less than half a wave-length, or say a one-hundred-thousandth of an inch apart, cannot be distinctly separated. This is the theoretical limit for a microscope using ordinary light, and it has been practically reached. The early microscopists would have thought this more than satisfactory; but the limit puts a serious obstacle in the way of biological and medical progress to-day. For example, the pathogenic bacteria in many cases are about this size or less; and there is special interest in considering in what directions we may hope to go further.

Since microscopic resolution depends on having a fine structure in the light itself, something, though not perhaps very much, may be gained by the use of ultra-violet light instead of visible light. It then becomes necessary to work by photography. We are nearing the region of the spectrum where almost everything is opaque. In the visual region nearly every organic structure is transparent, and to get contrast stains have to be used which colour one part more deeply than the other. In the ultra-violet, on the other hand, we get contrast without staining and, as Mr. J. E. Barnard has shown, the advantage lies as much in this as in the increased resolving power. For example, using the strong ultra-violet line of the mercury vapour lamp, which has about half the wave-length of green light, he finds that a virus contained within a cell shows up as a highly absorptive body in

contrast with the less absorptive elements of the cell. So that ultra-violet microscopy offers some hope of progress in connexion with this fundamental problem of the nature of viruses.

With ultra-violet microscopy we have gone as far as we can in using short waves with ordinary lenses made of matter, for the available kinds of matter are useless for shorter waves than these, and it might well seem that we have here come to a definite and final end. Yet it is not so. There are two alternatives, which we must consider separately. Paradoxical as it may seem, for certain radiations we can make converging lenses out of empty space ; or alternatively we can make optical observations without any lenses at all.

The Electron Microscope

The long-standing controversy which raged in the nineties of the last century as to whether cathode rays consisted of waves or of electrified particles was thought to have been settled in favour of the latter alternative. But scientific controversies, however acutely they may rage for a time, are apt, like industrial disputes, to end in compromise ; and it has been so in this instance. According to our present views the cathode rays in one aspect consist of a stream of electrified particles ; in another, they consist of wave trains, the length being variable in inverse relation to the momentum of the particles.

Now cathode rays have the property of being bent by electric or magnetic forces, and far-reaching analogies have been traced between this bending and the refraction of light by solids ; indeed, a system of 'electron optics' has been elaborated which shows how a beam of cathode rays issuing from a point can be reassembled into an image by passing through a localized electrostatic or magnetic field having axial symmetry. This constitutes what has been called an electrostatic or magnetic lens. It is then possible to form a magnified image of the source of electrons on a fluorescent screen, and that is the simplest application. But we can go further and form an image of an obstructing object such as a fine wire by means of one magnetic lens, acting as objective, and amplify it by means of a second magnetic lens, which is spoken of as the eyepiece, though of course it is only such by analogy, for the eye cannot deal directly with cathode rays. The eyepiece projects the image on to a fluorescent screen, or photographic plate.

So far we have been thinking of the electron stream in its corpuscular aspect. But we must turn to the wave aspect when it comes to consideration of theoretical resolving power. The wave-length associated with an electron stream of moderate velocity is so small that if the electron microscope could be brought to the perfection of the optical microscope, it should be able to resolve the actual atomic structure of crystals. This is very far indeed from being attained, the present electron microscope being much further from its own ideal than were the earliest optical microscopes. Nevertheless, experimental instruments have been constructed which have a resolving power several times better than the modern optical microscope. The difficulty is to apply them to practical biological problems.

It is not to be supposed that the histological technique so skilfully elaborated for ordinary microscopy can at once be transferred to the electron microscope. For example, the relatively thick glass supports and covers ordinarily used are out of the question. Staining with aniline dyes is probably of little use, and the fierce bombardment to which the delicate specimen is necessarily exposed will be no small obstacle. Certain standard methods, however, such as impregnation with osmium, seem to be applicable : and there is some possibility that eventually the obscure region between the smallest organisms and the largest crystalline structure may be explored by electron microscopy.

Use of X-Rays

In referring to the limitations on the use of lenses, I mentioned the other alternative that we might, in order to work with the shortest waves, dispense with lenses altogether : and in fact in using X-rays this is done. We are then limited to controlling the course of the rays by means of tubes or pinholes. This restriction is so serious that it altogether defeats the possibility of constructing a useful X-ray microscope analogous to the optical or the electron microscope. In spite of this, the use of X-rays is of fundamental value for dealing with a particular class of objects, namely, crystals, which themselves have a regular spacing, comparable in size with the length of the waves. Just as the spacing of a ruled grating (say 1/20,000 of an inch) can be compared with the wave-length of light by measuring the angle of diffraction, so the spacing of atoms in a crystal can

be compared with the wave-length of X-rays. But here the indications are less direct than with the microscope, and depend on the object having a periodic structure. So that the method scarcely falls within the scope of this address. How essential the difference is will appear if we consider that the angle to be observed becomes greater and not less the closer the spacing of the object under test.

Colour

Colour vision is one of Nature's most wonderful achievements, though custom often prevents our perceiving the wonder of it. We take it for granted that anyone should readily distinguish the berries on a holly bush, and we are inclined to be derisive of a colour-blind person who cannot do so. But so far anatomy has told us little or nothing of how the marvel is achieved. Experiments on colour vision show that three separate and fundamental colour sensations exist. It is probable that the cones of the retina are responsible for colour vision, and the rods for dark-adapted vision which does not discriminate colour. But no division of the cones into three separate kinds corresponding to the three colour sensations has ever been observed. Nor is any anatomical peculiarity known which allows a colour-blind eye to be distinguished from a normal one.

Can artificial resources help to improve colour discrimination? In some interesting cases they can. Indeed, the whole subject of spectroscopy may be thought of as coming under this head. We can recognize the colour imparted by sodium to a flame without artificial help. When potassium is present as well, the red colour due to it can only be seen when we use a prism to separate the red image of the flame from the yellow one. Such a method has its limitations, because if the coloured images are more numerous they overlap, and the desired separation is lost. To avoid this, it is necessary to make a sacrifice, and to limit the effective breadth of the flame by a more or less narrow slit; and if the images are very numerous the slit has to be so narrow that all indication of the breadth of the source is lost. This, of course, is substantially the method of spectroscopy, into which I do not enter further.

There is an interesting class of cases, however, where we cannot afford to sacrifice the form of the object entirely to colour discrimination. Consider, for example, the prominences of the sun's limb, which are so well seen against the darkened sky of an eclipse, but are altogether lost in the glare of the sky at other times. In order to see them, prismatic dispersion is made use of, and separates the monochromatic red light of hydrogen from the sky background. A slit must be used to cut off the latter: but if it is too narrow the outlines of the prominence cannot be seen. By using a compromise width, it is possible to reconcile the competing requirements in this comparatively easy case. Indeed, M. B. Lyot, working in the clear air of the observatory of the Pic du Midi, where there is less false light to deal with, has even been able to observe the prominences through a suitable red filter, which enables the whole circumference of the sun to be examined at once, without the limitations introduced by a slit.

A much more difficult problem is to look for bright hydrogen eruptions projected on the sun's disk, and at first sight this might well seem hopeless. A complete view of them was first obtained by photography, but I shall limit myself to some notice of the visual instrument perfected by Hale and called by him the spectrohelioscope. A very narrow slit has to be used, and hence only a very small breadth of the sun's surface can be seen at any one instant. But the difficulty is turned by very rapidly exposing to view successive strips of the sun's surface side by side. The images then blend, owing to persistence of vision, and a reasonably broad region is included in what is practically a single view. I must pass over the details of mechanism by which this is carried out.

There are now a number of spectrohelioscopes in different parts of the world, and a continuous watch is kept for bright eruptions of the red hydrogen lines. Already these are found to be simultaneous with the 'fading' of short radio waves over the illuminated hemisphere of the earth, and the brightest eruptions are simultaneous with disturbances of terrestrial magnetism. At the Mount Wilson Observatory, such eruptions have been seen at the same time at widely separated points on the sun, indicating a deep-seated cause. There are therefore very interesting and fundamental questions within the realm of this method of investigation.

The Photographic Plate

We have so far been mainly considering how we may adapt our vision for objects too small or too far off for unassisted sight, and for colour

differences not ordinarily perceptible. This is chiefly done by supplementing the lens system of the eye by additional lenses or by prisms. We cannot supplement the retina, but in certain cases we can do better. We can substitute an artificial sensitive surface which may be either photographic or photo-electric.

That certain pigments are bleached by light is an observation that must have obtruded itself from very early times—indeed, it is one of the chief practical problems of dyeing to select pigments which do not fade rapidly. If a part of the coloured surface is protected by an opaque object —say a picture or a mirror hanging over a coloured wallpaper—we get a silhouette of the protecting object, which is in essence a photograph.

Again, it is a matter of common observation that the human skin is darkened by the prolonged action of the sun's light, and here similarly we may get what is really a silhouette photograph of a locket, or the like, which protects the skin locally. In this case we are perhaps retracing the paths which Nature herself has taken : for the evolution of the eye is regarded as having begun with the general sensitiveness to light of the whole surface of the organism.

The sensitivity of at all events the dark-adapted eye depends on the accumulation on the retinal rods of the pigment called the visual purple, of which the most striking characteristic is its ready bleaching by light. We can even partially 'fix' the picture produced in this way on the retina of, for example, a frog by means of alum solution. This brings home to us how clearly akin are the processes in the retina to those in the photographic plate, even though the complexity of the former has hitherto largely baffled investigation.

There are then many indications in Nature of substances sensitive to light, and quite a considerable variety of them have from time to time been used in practical photographic processes. But compounds of silver, which formed the basis of the earliest processes, have maintained the lead over all others. The history of photography by means of silver salts cannot be considered a good example of the triumph of the rational over the empirical. For example, the discovery of developers came about thus. The first workers, Wedgewood and Davy (1802), had found that they got greater sensitivity by spreading the silver salt on white leather instead of paper. An early experimenter, the Rev. J. B. Reade (1837), was anxious to repeat this experiment, and sacrificed a pair of white kid gloves belonging to his wife for the purpose. When he wished to sacrifice a second pair, the lady raised a not unnatural objection, and he said, "Then I will tan paper." He treated paper with an infusion of oak galls and found that this increased the sensitivity greatly. It amounted to what we should call exposing and developing simultaneously. But, in using the method, it is easily observed that darkening continues after exposure is over, and this leads to beginning development after the exposure. This step was taken by Fox Talbot a year or two afterwards. Instead of crude infusion of galls he used gallic acid. Later, pyrogallic acid was used instead of gallic acid, and still survives.

The use of gelatine as a medium to contain the silver halide was a more obvious idea. But it was not so easy to foresee that the sensitivity of silver salts would be much further increased when they were held in this medium. For long this remained unexplained, until it was noticed that some specimens of gelatine were much more active than others. This was ultimately traced by S. E. Sheppard to the presence of traces of mustard oil, a sulphur compound, in the more active specimens. This, in turn, depends in all probability on the pasturage on which the animals that afford the gelatine have been fed. The quantity present is incredibly small, comparable in quantity with the radium in pitchblende.

The value to science as well as to daily life of the gelatine dry plate or film can scarcely be overestimated. Take, for example, the generalized principle of relativity, which attempts with considerable success to reduce the main feature of the cosmical process to a geometrical theory. The crucial test requires us to investigate the gravitational bending of light, by photographing the field of stars near the eclipsed sun. For this purpose, the gelatine dry plate has been essential : and here, as we have seen, we get into complicated questions of biochemistry. This is to my mind a beautiful example of the interdependence of different branches of science and of the disadvantages of undue specialization (or should I say generalization ?). We may attempt to reduce the cosmos to the dry bones of a geometrical theory ; but in testing the theory we are compelled to have recourse again to the gelatine which we have discarded from the dry bones !

To come back, however, to the development of the photographic retina, as I may call it. As is well known, the eye has maximum sensitivity to

the yellow-green of the spectrum, but ordinary silver salts are not sensitive in this region. Their maximum is in the blue or violet, and ranges on through ultra-violet to the X-ray region. It was not at all easy to extend it on the other side through green, yellow and red to infra-red. The story of how this was ultimately attained is one more example in the chapter of accidental clues skilfully followed up which forms the history of this subject.

In 1873, Dr. Hermann Vogel, of Berlin, noticed that certain collodion plates of English manufacture, which he was using for spectrum photography, recorded the green of the spectrum to which the simple silver salts are practically insensitive. The plates had been coated with a mixture which contained nitrate of uranium, gum, gallic acid, and a yellow colouring matter. What the purpose of this coating was is not very obvious. It rather reminds one of medieval medical prescriptions which made up in complexity what they lacked in clear thinking. But Vogel concluded with true scientific insight that it must owe the special property he had discovered to some constituent which absorbs the green of the spectrum more than the blue: for conservation of energy requires that the green should be absorbed if it is to act on the plate. He then tried staining the plate with coralline red, which has an absorption band in the green, with the expected result. With much prescience he says: "I think I am pretty well justified in inferring that we are in a position *to render bromide of silver sensitive for any colour we choose.* Perhaps we may even arrive at this, namely photographing the ultra-red as we have already photographed the ultra-violet." It was, however, half a century before this far-seeing prophecy was fully realized. The development of the aniline colour industry gave full scope for experiment; but it has been found by bitter experience that dyes which can produce the colour sensitiveness are often fatal to the clean working and keeping qualities of the plate. However, success has been attained, largely by the efforts of Dr. W. H. Mills, of the chemical department of the University of Cambridge, and of Dr. C. E. K. Mees, of the Kodak Company; and we all see the fruits of it in the photographs by lamplight which are often reproduced in the newspapers.

It is now known in what direction the molecular structure of the sensitizing dye must be elaborated in order to push the action further and further into the infra-red, and the point when water becomes opaque has nearly been reached, with great extension of our knowledge of the solar spectrum. The spectra of the major planets have also been extended into the infra-red, and this has given the clue as to the true origin of the mysterious absorption bands due to their atmospheres, which had baffled spectroscopists for more than a generation. These bands have been shown by Wildt to be due to methane or marsh gas. Neptune, for example, has an atmosphere of methane equivalent to 25 miles thickness of the gas under standard conditions. In this Neptunian methane we have a paraffin certainly not of animal or vegetable origin; and I venture in passing to make the suggestion that geologists might usefully take it into consideration in discussing the origin of terrestrial petroleum.

Photo-Electric Surfaces

The photographic plate is not the only useful substitute for the human retina. We have another in the photo-electric surface. The history of this discovery is of considerable interest. Heinrich Hertz, in his pioneering investigation of electric waves (1887), made use of the tiny spark which he obtained from his receiving circuit as an indicator. His experiments were done within the walls of one room. When he boxed in the indicating spark so as to shield it from daylight and make it easier to see, he found that this precaution had exactly the opposite effect—the spark became less instead of more conspicuous. To express it shortly and colloquially, this action was found to depend on whether or not the spark of the receiver could see the spark of the oscillator. Moreover, seeing through a glass window would not do. It was ultra-violet light from the active spark that influenced the passive spark. Further, Hertz was able to determine that the action occurred mainly, if not entirely, at the cathode of the passive spark.

The next step was taken by Hallwachs, who showed that it was not necessary to work with the complicated conditions of the spark. He found that a clean zinc plate negatively charged rapidly lost its charge when illuminated by ultra-violet light.

The final important step was in the use of a clean surface of alkali metal *in vacuo*, which responds to visible light, and passes comparatively large currents. This constitutes the photo-electric cell very much as we now have it, and was due to two German schoolmasters, J. Elster and

H. Geitel. English physicists who met them during their visit to Cambridge a generation ago will not fail to have agreeable memories of their single-minded enthusiasm and devoted mutual regard. Sir J. J. Thomson has recalled them to our recollection in his recent book. They could scarcely have foreseen that their work, carried out in a purely academic spirit, would make possible the talking films which give pleasure to untold millions.

The sensitiveness of the dark-adapted eye has often been referred to as one of its most wonderful features; but, under favourable conditions, the sensitivity of a photo-electric surface may even be superior. According to our present ideas, no device conceivable could do more than detect every quantum which fell upon it. Neither the eye nor the photo-electric surface comes very near to this standard, but it would seem that the falling short is rather in detail than in principle. The action of the photo-electric cell depends on the liberation of an electron by one quantum of incident energy, and under favourable conditions the liberation of one electron can be detected, by an application of the principle of Geiger's counter. The action of the dark-adapted eye depends on the bleaching of the visual purple. According to the results of Dartnell, Goodeve and Lythgoe, it appears likely that one quantum can bleach a molecule of this substance, and in all probability this results in the excitation of a nerve fibre, which carries its message to the brain.

The photo-electric cell can be used like the photographic plate at the focus of an astronomical telescope. It might seem from the point of view of evolution a retrogade step to substitute a single sensitive element for the 137 million such elements in the human eye. In this connexion, it is interesting to note that, in certain invertebrate animals, eyes are known which have the character of a single sensitive element, with a lens to concentrate the light upon it. Such an eye can do little more than distinguish light from darkness. But its artificial counterpart using the photo-electric surface has the valuable property that the electric current which indicates that light is falling upon it can be precisely measured, so as to determine the intensity of the light. In contrast with photographic action, the energy available to produce the record comes not from the original source of light, which only, as it were, pulls the trigger, but from the battery in the local circuit, and it may be amplified so as to actuate robust mechanisms. It has been applied with success to guiding a large telescope or, in a humbler sphere, to open doors, or even to catch thieves.

However, the scientific interest lies more in the possibility of accurate measurement. As an interesting example we might take the problem of measuring the apparent diameter of the great nebula in Andromeda. As is known, modern research tends to indicate that the Andromeda nebula and other like systems are the counterparts of the galaxy, being in fact island universes. But until lately there was such a serious difficulty in that all such systems appeared to be considerably smaller than the galaxy. Stebbins and Whitford, by traversing a telescope armed with a photo-electric cell across the nebula, have found that its linear dimensions were twice as great as had been supposed, reducing the discrepancy of size to comparatively little.

Television

But, it may be suggested, could we not go further and make a photo-electric equivalent, not only for the rudimentary kind of eye, which has only a single sensitive element, but also for the developed mammalian eye, which has an enormous number? Could we not build up on separated photo-electric elements a complete and detailed picture? In point of fact this has been done in the development of television; and since this new art which interests us all can properly be considered as an extension of the powers of normal vision, no excuse is needed for devoting some consideration to it.

We must divide the photo-electric surface into minute patches which are electrically insulated from one another. This is not too difficult; but if it were proposed directly to imitate Nature, and attach a wire, representing a nerve fibre, to each of these patches, so as to connect it to the auxiliary apparatus, we might well despair of the task; for there are probably half a million such connexions between the human retina and the brain. In the artificial apparatus for television, one single connexion is made to serve, but it is in effect attached to each of the patches in rapid succession by the process of 'scanning' the image. The photo-electric mosaic is on one side of a thin mica sheet, and a continuous metal coating on the other side gives the connexion, which is by electrostatic induction. Each element of the surface forms a separate tiny condenser with the opposing part of the back plate.

Scanning is achieved by rapidly traversing a beam of electrons over the mosaic line by line. The whole surface, and therefore each element, must be scanned at least twenty times a second. In the intervals an element is losing electrons more or less rapidly. The scanning beam comes along, and restores the lost electrons, discharges the little condenser formed by the element and the back plate, and sends an electric signal into the wire attached to this plate. The strength of this signal will depend on how many electrons the element had lost since the previous scanning, and thus on the luminous intensity of that part of the image. An important point is that the element is in action all the time, and not only while it individually is being scanned.

We have thus transmuted the momentary picture into a series of electric pulses occupying in all a time of one twentieth of a second, and these can be amplified and sent out as wireless signals. How are they to be turned back again into a visible picture at the other end? Well, that is not, perhaps, so difficult as the first conversion of the picture into signals. We must make a beam of electrons follow and imitate the periodic movements of the scanning beam at the other end. The beam of electrons falls on a luminescent screen, and makes it light up, more or less brightly according to the intensity of the electron beam. If we use the incoming signals to modulate the electron beam, we can make them correspond with the intensities at the sending end, and the original picture is reconstructed piece by piece. The reconstruction is completed in one twentieth of a second or less, and the process begins again. The successive pictures blend into one another as in the cinema, and movement is shown with apparent continuity.

It seems not unlikely that the electric eye or iconoscope, as it has been called, may have applications apart from television. Dr. V. K. Zworykin, who took an important part in its development, suggested that it might be used to make visible the image in the ultra-violet microscope, which would be much too faint for direct projection on a fluorescent screen. For that purpose the sending and receiving apparatus would, of course, be connected directly, without radio transmission. It might also be used for rapid photography, if the photographic plate replaced the viewing screen. The beauty of the device is that the energy is supplied locally, the distant light source merely releasing it. The principle of amplification may thus perhaps be applied to the photographing of faint objects.

I come to the close of this part of my subject. Much of modern scientific doctrine appears at first sight to have an elusive and even metaphysical character, and this aspect of it seems to make the strongest appeal to many cultivated minds. Yet upon the whole, the main triumphs of science lie in the tangible facts which it has revealed; and it is these which will without doubt endure as a permanent memorial to our epoch. My main thesis has been that these are discovered by methods not essentially different from direct scrutiny. It is hoped that the present survey may remind you that if we allow for a reasonable broadening of the original meaning of the words, it remains true, after all, that "seeing is believing".

Part II

During the Great War itself, few scientific men in any country doubted that it was their duty to do what they could to apply their specialized knowledge to the purposes of war; nor was it often suggested by publicists that there was any countervailing consideration: on the contrary, they urged strongly that our resources in this direction should be efficiently mobilized. It is chiefly in vague general discussions that the opposite view becomes vocal.

Science, it is urged, is the source of all the trouble: and we may look to scientific men for some constructive contribution to finding a remedy. It is worth while to inquire what basis there is for this indictment, and whether, in fact, it is feasible for men of science to desist from labours which may have a disastrous outcome, or at any rate to help in guiding other men to use and not to abuse the fruits of those labours. I may say at the outset that I have no sanguine contribution to make. I believe that the whole idea that scientific men are specially responsible is a delusion born of imperfect knowledge of the real course of the process of discovery. Indeed, very much the same complaint was made before the scientific era. Let me refer you to Shakespeare's play, "Henry IV":

> "Great pity, so it was
> This villainous saltpetre should be digged
> Out of the bowels of the harmless earth
> Which many a good tall fellow had destroyed
> So cowardly."

The quotation leads us to inquire how far the further development of this particular kind of frightfulness into modern high explosives was deliberate or not.

In the course of systematic study of the chemistry of carbon compounds it was inevitable that the action of nitric acid on substances like benzene, toluene, glycerine, cellulose, and the like should be tried. No one could foresee the result. In the case of benzene, we have nitrobenzene, the key to the aniline dye industry. In the case of glycerine, Sobrero obtained in 1846 the highly explosive liquid called nitro-glycerine. He meant no harm, and in fact his discovery lay dormant for many years, until Nobel turned his attention to the matter in 1863, and showed how by mixing nitro-glycerine with other substances, solid explosives could be made which admitted of safe handling. Dynamite was one of them. They proved invaluable in the arts of peace, for example, in mining and in making railway tunnels, such as those through the Alps. They were used by the Irish Fenians in the dynamite outrages of the 'eighties. These attempted outrages were not very successful, and so far as I know no one was inclined to blame science for them, any more than for the Gunpowder Plot. Like the latter, they came to be considered slightly comic. If anyone doubts this, he may agreeably resolve his doubts by reading R. L. Stevenson's story, "The Dynamiter". At all events, high explosives had been too long in use in peaceful industry for their misuse to be laid directly to the account of science.

Coming next to poison gas. We read that Pliny was overwhelmed and killed by sulphur dioxide in the eruption of Vesuvius in A.D. 79. During the Crimean War, the veteran admiral Lord Dundonald urged that the fumes of burning sulphur should be deliberately used in this way, but the suggestion was not adopted. Even if it had been, scientific research *ad hoc* would obviously have had little to do with the matter. During the Great War, chlorine was used on a large scale. I need scarcely insist that chlorine was not isolated by chemists for this purpose. It was discovered a hundred and forty years before, as a step in the inquiry into the nature of common salt.

Coming to the more recondite substances, we may take mustard gas—really a liquid—as typical. It is much more plausible to suggest that here was a scientific devilment, deliberately contrived to cripple and destroy. But what are the real facts?

Referring to Watts's "Dictionary of Chemistry" (edition of 1894), there is an article of less than forty words about mustard gas (under the heading of dichlordiethyl sulphide). After the method of preparation used by Victor Meyer has been mentioned, the substance is dismissed with the words, "oil, very poisonous, and violently inflames the skin. Difference from diethyl sulphide."

There are sixteen other compounds described at comparable length on the same page. So far as I know, none of them is of any importance. A not uncommon type of critic would probably say that the investigation of them had been useless, the work of unpractical dreamers, who might have been better employed. One of these substances, namely mustard gas, is quite unexpectedly applied to war, and the production of it is held by the critics to be the work not of dreamers, but of fiends whose activities ought to be suppressed!

Finally, at the bottom of the page begins a long article on chloroform. This substance, as you know, has relieved a great deal of pain, and on the same principle the investigator who produced it was no doubt an angel of mercy. The trouble is that all the investigators proceeded in exactly the same spirit, the spirit that is of scientific curiosity, and with no possibility of telling whether the issue of their work would prove them to be fiends, or dreamers, or angels.

Again, there is the terror of thermite incendiary bombs, spreading fire broadcast throughout great cities. The notion is sometimes encountered that thermite was invented for this purpose. Nothing could be further from the truth. I first made acquaintance with it myself in 1901 by hearing a lecture at the Royal Institution by the late Sir William Roberts Austen on "Metals as Fuel". He directed attention to the great amount of energy which was liberated when aluminium combined with oxygen, and showed how aluminium powder mixed with red oxide of iron would react violently with it, withdrawing the oxygen from the iron, and becoming brilliantly incandescent in the process. He showed further how this mixture, called thermite, could be used for heating metal work locally, so as to make welds, for example, in joining two iron pipes end to end. I venture to say that it never occurred to him or to any of his hearers that thermite had any application in war.

In discussions of this kind a distinction is often implied between what I may call old-fashioned knowledge and modern scientific knowledge. The latter is considered to be the special handmaid of 'frightfulness'. The futility of this distinction is

easily seen by considering a special case. Iron is thought of as belonging to the pre-scientific era, while aluminium is thought to belong to the scientific era. From the point of view of chemistry, both are metals, and the problem of producing them in either case is a chemical one. When produced they both have their function in 'frightfulness': iron to cut and stab; aluminium to make thermite bombs to burn and destroy. If modern science makes its contribution to 'frightfulness' in giving us aluminium, ancient craft did so in giving us iron. It is obviously absurd to make any distinction in principle between the two cases. Science properly understood includes all real knowledge about material things, whether that knowledge is old or new.

All these terrors have only become applicable against a civilian population by the development of aircraft. Military objects were certainly not the incentive of the successful pioneers of artificial flight. They were fascinated at first by the sport of gliding, and afterwards by a mechanical transport problem.

It is true that brilliant writers of imaginative fiction, such as Jules Verne and H. G. Wells, had foretold all, and more than all, the horrors that have since come to pass. But it is perhaps more to the point to inquire what were the contemporary views of practical men. The Wrights made their first successful flight in 1903. In 1904, I myself heard the then First Sea Lord of the Admiralty repudiate with scorn the suggestion that the Government were interesting themselves in the matter; and I know with equal definiteness that even so late as 1908 the Chief of the Imperial General Staff did not believe in the military importance of flight. Would it be fair then to blame the inventors for not having realized it, and for not having stayed their hands?

Summing up what may be learnt from the experience of the past, I think we may say that the application of fundamental discoveries in science to purposes of war is altogether too remote for it to be possible to control such discoveries at the source.

For good or ill, the urge to explore the unknown is deep in the nature of some of us, and it will not be deterred by possible contingent results, which may not be, and generally are not, fully apparent until long after the death of the explorer. The world is ready to accept the gifts of science, and to use them for its own purposes. It is difficult to see any sign that it is ready to accept the advice of scientific men as to what those uses should be.

Can we then do nothing? Frankly, I doubt whether we can do much, but there is one thing that may be attempted. The British Association has under consideration a division for study of the social relations of science which will attempt to bring the steady light of scientific truth to bear on vexed questions. We rejoice to know that our distinguished American visitors are in sympathy with this aim, and we hope that our discussions with them will bear useful if modest fruit in promoting international amity.

SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS*

Logic and Probability in Physics

AFTER paying a short tribute to the memory of Lord Rutherford, the president of Section A (Mathematical and Physical Sciences), Prof. C. G. Darwin, comes to his main subject, which is the inadequacy of the reasoning processes which have in the past been regarded as the proper machinery of scientific thought. We have set up as the ideal form of reasoning the formal logic of Aristotle; we rarely conform to this ideal, but instead we make use of arguments having no accurate axiomatic basis, which compel belief because of some large accumulation of favourable evidence. The old logic was devised for a world that was thought to have hard outlines, and now that we know that the outlines are not hard the method of reasoning must be changed. The key to the modification lies in probability, but whereas in the past it was expected that probability could somehow be fitted into the old logic, the attempt has always failed, and we must recognize it as an independent principle. Our instincts only accept this with difficulty, but a similar unsatisfying state of affairs used to exist in mechanics, which has been overcome by the quantum theory, and an analogy may be developed between the two cases.

There follows a review of the history of the quantum theory, touching on a number of points of interest, but having special reference to the way in which it has dealt with causality. The old mechanics seemed to point with all the compulsive force of a logical syllogism to absolute determinism. We are still scarcely free from the feeling of this compulsion, but we know it is wrong, and we know where the fault lay. An analogy may be made between this state of affairs and our feeling about the place of probability in logic. We used to feel that classical mechanics provided no room for anything outside itself, and we feel that the old logic is the only really admissible form of reasoning. Certain things refused to fit into the classical scheme and led to the old quantum theory, and we have found that the old logic is inadequate without the supplementary principle of probability. In mechanics the union is completed by the new quantum theory, but we have not yet satisfactorily blended our reasoning principles.

The sort of way the union may come about is suggested by another branch of physical theory, the kinetic theory of gases. One of the most important ideas in the statistical theory of matter has been Gibbs's ensemble. With the old mechanics the ensemble was a rather strange idea, and it was hard to see where it came from, but now it fits beautifully into the new mechanics, for any actual piece of gas is not merely a single member from among the countless representatives in the ensemble, but is itself the whole ensemble. This example suggests a real synthesis of probability with our other reasoning processes, and gives the hope of a true reasoning adapted not to the artificially simplified world of hard outlines of the classical mechanics, but to the real world with its slightly indefinite outlines.

The address concludes with a plea for a reform of our education at both school and university, so that probability and statistics should be given a proper share in our mathematical courses. At present all the attention is given to things susceptible of exact proof, and none to the things of much more frequent occurrence where inaccuracies, tolerances or fluctuations are also of interest. It is not so much that new special courses are needed as that the emphasis should be altered in the ordinary courses of mechanics and kindred subjects. The mathematics would not be any more difficult than in the customary courses, but the train of thought is at present unfamiliar, and it would not be hard to remove this unfamiliarity. In this way the student would acquire a much juster appreciation of the physical world than can ever be acquired by an exclusive attention to those things which are capable of exact proof.

Recent Investigations in the Chemistry of Gold

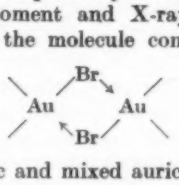
THE recent advances in our knowledge of the chemistry of gold have for the most part been due to investigations carried out by workers in Great Britain; amongst others, H. Bassett, E. G. Cox, F. G. Mann, Sir Gilbert Morgan, Sir William Pope, W. Wardlaw, and their respective co-workers. This work, together with that of the president of Section B (Chemistry), Prof. C. S. Gibson, and his collaborators, which forms the topic of Prof. Gibson's presidential address, has emphasized the similarities and also the striking anomalies existing among the currency metals, copper, silver and gold, the metals of Sub-group 1 *B* of the Periodic

* Lord Rayleigh's presidential address, and the addresses of the sectional presidents, are being published as "The Advancement of Science, 1938". (Cambridge: B.A. Reception Room. London: Burlington House.) 3*s.* 6*d.*

Classification. These anomalies are unexplained but are, to some extent, correlated with those existing among the transitional metals.

Copper, silver and gold all exist in the univalent condition, but in this state only silver is, from a chemical point of view, a typical metal, since cuprous copper and aurous gold do not form normal salts. In their compounds, cuprous copper and aurous gold are always co-ordinated, but whereas cuprous copper may be 2- and 4-covalent, aurous gold is always 2-covalent, and no compounds are known in which it has a higher co-ordination number. Argentous silver may be 2- and 4-covalent; its co-ordination compounds are almost completely analogous with the corresponding cuprous compounds, and the four valencies of cuprous copper and argentous silver have a tetrahedral configuration. Unlike cupric copper, bivalent or argentic silver is chemically not a typical metal, since it only forms co-ordinated complexes which may be present in electrolytes and non-electrolytes. When it is 4-covalent, argentic silver forms compounds which are analogous and isomorphous with the corresponding cupric compounds, and the four valencies of cupric copper and argentic silver have a planar configuration. One striking anomaly among these metals is the non-existence of bivalent gold. In the tervalent or auric condition, gold again is chemically not a typical metal and is always 4-covalent. Consequently, unlike copper and silver, gold never assumes the 'effective atomic number' (Sidgwick) of the next inert gas. X-ray crystallographic examination has demonstrated the planar configuration of the four valencies of tervalent gold and the linear configuration of the two valencies of univalent gold.

What may be described as the new chemistry of gold has arisen from the study of the organic derivatives of the metal, which were discovered by Sir William Pope and C. S. Gibson in 1907, and their investigation has been extended by Gibson and his collaborators during the last seven years. The organic compounds of gold most readily accessible are colourless crystalline non-electrolytes having the general formula $(R_2AuX)_2$, R and X representing univalent hydrocarbon radicals and halogen atoms respectively. As shown by the low dipole moment and X-ray crystallographic examination, the molecule contains the planar ring structure



which is present in many auric and mixed auric-aurous compounds.

From the bromine derivatives are easily prepared deep red crystalline non-electrolytes having the general formula $(RAuBr_2)_2$. These compounds have high dipole moments and contain the same planar heterocyclic ring containing two 4-covalent auric atoms to one of which two hydrocarbon radicals are attached. In agreement with their constitution, these compounds behave chemically as equimolecular mixtures of the compounds $(R_2AuBr)_2$ and of gold tribromide, $(AuBr_3)_2$, the latter compound having the same planar heterocyclic ring mentioned above.

The remarkable tendency, due to co-ordination, for auric and, to a less extent, aurous gold to become members of heterocyclic ring systems is further illustrated by the interesting colourless non-electrolyte, diethylgoldacetylacetone and also by the cyano derivatives obtained by the action of silver cyanide on the first-mentioned compounds. These cyano compounds are non-electrolytes having the general formula $(R_2AuCN)_4$, and the molecule, as shown by the low dipole moment and X-ray crystallographic investigation (H. M. Powell and R. F. Phillips), contains a planar twelve-atom ring having four symmetrically situated 4-covalent auric atoms. These compounds have the additional interest in that, spontaneously or on gentle heating, they yield free hydrocarbon radicals. The first stage of this decomposition yields a mixed 4-covalent auric and 2-covalent aurous compound, $(RAuCN)_4$, the molecule of which again has a twelve-atom planar ring structure containing two symmetrically placed auric and two symmetrically placed aurous atoms, the latter being 2-covalent.

There being no evidence that gold can have higher covalencies than two when it is aurous and four when it is auric precludes the possibility of obtaining optically active gold compounds in which the gold atom is the centre of asymmetry.

Development and Evolution

THE Theory of Recapitulation, which at the opening of this century tended to dominate biological and palæontological thought upon the relationship of development to evolution, has in these latter days fallen into disrepute. This state of affairs is reflected in recent literature by a diversity of views, ranging from complete rejection of the theory to almost unqualified acceptance. Prof. H. H. Swinnerton, in his presidential address to Section C (Geology) seeks, by reference to palæontological evidence, to elucidate the causes of this wide diversity of opinion and to harmonize the observations out of which it has arisen.

In so far as developmental changes reflect evolutionary changes of the past, or foreshadow those which are to come, the relationship of

development to evolution is either retrospective or prospective. Failure to keep these two aspects distinct from one another has been the cause of much of the confusion of thought which exists.

The palæontological evidence used in the address is limited to well-authenticated material, made up of numerous specimens carefully collected from known horizons, and is of such a quality that the development of individuals could be worked out with reasonable fullness.

Dealing in the first place with the retrospective aspect of the problem, it is helpful to distinguish between the very early, or embryonic, stages of development and the later, or neanic stages, during which the young gradually assumes the characteristics of the adult. A careful comparison of the development with the successive stages of evolution shows that in some cases there is a remarkably close resemblance between the changes passed through in the neanic period and the changes exhibited by the adults of previous generations. This proves that recapitulation of evolutionary stages as manifested by adults does actually take place. On the other hand, the conditions seen in the embryonic phases exhibit little or no resemblance to any known adult ancestor, but they do resemble very closely the corresponding juvenile stages both of ancestral and of allied forms. This distinction between juvenile and adult recapitulation corresponds with the different bodies of facts observed and emphasized respectively by von Baer and Haeckel, and by their present-day followers.

Though the recapitulation of the complete combination of adult characters seems to be confined to the lower forms of life, the limited recapitulation of individual characters is widely spread even in the highest grades of animals.

Turning to the prospective aspect of the subject, it should be noted that new characters (cœnogenetic) may appear at an early stage of development. Some of these are limited in their occurrence to these stages ; others may extend, in subsequent generations, to later or even adult life. Where this happens, the recapitulatory record may be seriously vitiated. New characters (deuterogenetic) may also appear in the latest stages of development. Such tend, in subsequent generations, to pass back to successively earlier neanic stages, and thus build up a recapitulatory record.

In both these cases the rate at which the new characters attain full expression in evolution varies greatly. In some racial stocks it is attained slowly with the passage of a long period of time. In others the successive phases of expression may come quite rapidly. Occasional instances occur in which the rate of expression appears to be so rapid as to suggest simultaneous mutation. In such cases a false impression of serial evolutionary change is produced by the progressive elimination of individual types in the order of the phases in the series.

In conclusion, it may be suggested that the development of the individual exhibits a body of characters derived from both adult and juvenile stages in the life of its ancestors. This provides a framework into which subsequent evolutionary changes may be fitted. This fitting is carried out by various processes which may proceed separately, simultaneously, or in sequence in the development of different individuals of allied organisms.

Fluctuations in the Abundance of Marine Animals

IN his presidential address to Section D (Zoology), Dr. Stanley Kemp directs attention to the great fluctuations in the abundance of marine animals and to the need for further study of their causes. Normal annual fluctuations, due for the most part to events which occur in the early stages of the animal's life, may be very great : it is not uncommon to find that one year-class of fish is fifty times as abundant as another. The evidence at present available, drawn from the incidence of good and bad survival years in a few of the more important European fishes, is that these annual fluctuations are strictly localized—a certain species in a particular place will be affected in one way, while another species in the same place, or the same species in another place, will be affected in a different way.

In recent years, it has become increasingly apparent that this is not the only kind of fluctuation to which marine animals are subject. There are others, here called long-period fluctuations, which are superposed upon the annual fluctuations and affect many, or perhaps all, species simultaneously over a wide area.

Two illustrations of such long-period fluctuations are given. In the Channel waters off Plymouth four separate lines of evidence show that since 1931 great changes have taken place. (1) Beginning with 1931, there has been a steady reduction in the numbers of larval fish in the offshore waters : the larvæ of summer-spawning fish have now on the average been reduced to one fifth of their former abundance and those of spring-spawning fish to one third. (2) A marked change has occurred in the constitution of the herring shoals which form the basis of the winter fishery at Plymouth. Since 1931, the proportion of the younger year classes of fish has been reduced from upwards of 66 per cent to less than 20 per cent : in the last

few years the fishery has suffered greatly and it is now virtually abandoned. (3) In 1930 (and though exact figures are not available it was evidently much the same in former years) the offshore plankton contained *Sagitta elegans*, which is characteristic of mixed Atlantic water, and *S. setosa*, which is characteristic of Channel water, in the proportions of 94 : 6 ; but since 1932, with a single exception in 1936, these proportions have been reversed. (4) The winter maximum of dissolved phosphate has over the same period shown a heavy decrease, amounting on the average to about 35 per cent. Comparable data from other areas are not available, but the failure in recent years of the Donegal herring fishery has been accompanied by a similar change in the constitution of the shoals and may be due to the same causes.

The changes in the Plymouth area are due, it seems, to the lack of influxes of phosphate-rich water from the Atlantic. Salinity and temperature records show, indeed, that incursions of Atlantic water have passed up the Channel ; but the records cannot be correlated with the biological and phosphate data, and the great influx of Atlantic water into the North Sea in 1921 is known to have been detrimental to the herring fisheries. It thus appears that influxes may be of more than one kind, and that only water rich in phosphate, or potentially rich because it carries an abundant plankton, will benefit the Channel fauna.

The second illustration of a long-period fluctuation is from northern waters. Here there have recently been great changes in the fauna, owing to a rise of 1° or 2° C. in the temperature of the water, and this is due, presumably, to an increase in the strength of the Atlantic drift. By reason of this change, many animals have been able to extend the limits of their distribution and in almost every section of the fauna significant movements have been noted ; profitable cod fisheries have been established at Bear Island and in West Greenland, and an unusual abundance of herring has been found on the Murman coast.

Long-period fluctuations are thus due to a widespread alteration in some hydrographic factor in the environment and though, in the two instances given, this factor is different—at Plymouth phosphate and in northern waters temperature—it is in the ocean to the west that the changes originate and it is here, in the open Atlantic, that the reasons must be sought. At present our knowledge of the circulation in the North Atlantic is very deficient, but with the work now in progress it is to be expected that the main features will shortly be better known. To the biologist, however, it is the irregularities in the system which are of primary importance, and it is only by regular and repeated observations carried out over a wide area that the causes of these long-period fluctuations can be discovered.

In conclusion, attention is directed to the need for greater activity in fishery administration throughout the Empire, for though there are some notable exceptions, it appears that the lessons we have learnt in Great Britain are not generally understood elsewhere. In almost every problem in marine biology it is essential to possess a background of fundamental knowledge, which can only be obtained by long years of patient study. In many parts of the Empire not even a beginning has been made in the acquisition of such knowledge ; there are vast areas in which no single species of fish can as yet be recognized in all its stages of development, while little or nothing is known of such matters as rate of growth, spawning periods, food, migrations and fluctuations in abundance. The importance of such information cannot be over-estimated, for the opportunity of dealing effectively with a fishery problem will almost invariably be lost unless knowledge has been obtained in advance and is ready for application.

Correlations and Culture : A Study in Technique

PROF. GRIFFITH TAYLOR'S presidential address to Section E (Geography) falls into three divisions. In the first the field of cultural geography is considered, in the second a technique which has been found invaluable in that subject is discussed and illustrated ; finally, suggestions are made as to the aspects of culture which should be included in a general education. The relation of geography to history, anthropology, sociology and philology is emphasized. It is shown that there are common fields of research in which the technique of the 'physical' scientist can be used by the cultural geographer to aid in problems in the 'humanistic' disciplines.

The aid geographers can give to historians is illustrated by examples from the Weald and from the blue-grass country of Kentucky. The characteristic cultural development in both is shown to depend on structure primarily, though most historians ignore this important correlation. The use of *isopleths* (lines of equal abundance) can be used with profit in an interpretation of the essential features of the Renaissance. As an indicator of *trends* and *salient features*, they might well be more extensively used by the historian.

The geographer's task should be to teach the student to doubt dogmas involving distribution, and to make his own deductions from fundamental data. In a general education this is a far more valuable function than memorizing economic data, which fills so much of geographic teaching to-day.

One of the main purposes of the address is to show that from the *map* of the distribution of culture-facts, the investigator can deduce the cradle of the various cultures and the order of their evolution. This principle, long used by the botanist and biologist, is of great value to the anthropologist, sociologist and philologist. The *distributions* of man, of various industries and populations, of languages, etc., belong to the field of the geographer. A lengthy study of such distributions leads to views often much at variance with those accepted as orthodox. Some examples discussed are the cradle-land of man, the differentiation of the races, the inaccuracy of the terms 'Caucasian' and 'Mongolian', the spread of cultures from Asia into the Pacific, and the probable cradle of civilization. In many of these problems the implications of the isopleths have been ignored by most researchers.

It is suggested that a new term is needed for groups which are linked by *culture*, but are not racial units. An extension of the use of the word *'cult'* is suggested. Thus there is no Jewish *race* in Europe, or French *race* in Canada; but it is logical to talk of a Jewish or French 'cult'. Race should denote 'breed', and is purely a *biological* concept. The problem of the Jews and of the Aryans is used to illustrate a glaring example of dangerous ignorance on the part of powerful political groups. A new technique of approaching linguistic relationships—based on distributions—is discussed. It seems to offer clues as to the relationships between, and the origins of, Aryan, Basque, Altaic, and other linguistic groups. Prof. Griffith Taylor believes that the Aryan languages originated near the Caspian. He suggests that the isopleths support the view that the Nordic race originally spoke Finn or some allied *non-Aryan* language.

Geographers may be classified in three groups: *theocratic* (that is, teleological), *environmental* or *possibilist*. A belief in environmental control, to which the name "Stop-and-go Determinism" has been given, is favoured. It is opposed to the orthodox views of geographic philosophy.

A drastic revision of the programme for a general cultural education is required, especially in the Dominions. Educators must abandon the technique of Augustine of Canterbury for that of Aristotle. The latter tried (in a living language) to put the youth of Greece *en rapport* with the vital problems of the day. He did not insist on their spending years trying to learn the long-dead language of Tutankhamen.

It would seem desirable to swing the attention of youth for a generation or two from a study of classics or of the problems of physical science to the more difficult and dangerous problems of social science. There is no risk to-day, though there was in the past, in stating that the earth is a globe, revolves around the sun, and is of infinitely small importance in the cosmos. But there is grave danger in many circles in stating the truth about Communism, Socialism, Judaism, Nordicism, and many other -isms which conflict with established or dictatorial interests. These creeds are cultural facts, which can be more readily understood if tackled in a *graphic* manner. It is no quibble to say that they are to-day more vital to the man of culture, that is, with a well-rounded education, than is the well-recognized and valuable culture based on art, music, or classics. Thus the geographer whose interests lie not only in the economic but also in the *cultural* field can feel that he is working right on the battle-front in man's progress towards a higher type of civilization.

Eighteen ecological diagrams form an essential feature of the address.

Scope and Method of Economics

THE object of the presidential address by Mr. R. F. Harrod to Section F (Economics) on *method* is threefold: (1) An attempt is made to show the kind of knowledge on which the practical recommendations, which economists have been in the habit of giving with a considerable degree of assurance, are grounded. (2) An attempt is made to define precisely the empirical basis of the general laws which constitute traditional economic theory. (3) Attention is given to the new ground over which contemporary theory, more tentative and more empirical, is striving to advance.

The recommendations do not issue from a set of 'laws' relating to the causal sequence of events. The scientific groundwork of these recommendations is a systematic classification of different kinds of economic activity and a simultaneous conspectus of the system as a whole. For example, the condemnation of protection is not based on precise knowledge of the sum of consequences likely to result from it; but when we have made a systematic classification of the purposes of economic effort and grasped the mode of operation of the system of a whole, we see that protection fails to take account of this, implicitly assumes a different working of the system and, save in exceptional circumstances, produces a net residue of frustation.

The economist's criterion of the good as that which is preferred is defined, and it is shown that it may be validly employed whatever the moral or political objectives of the society may be. The economist's criterion is free from

moral or political bias, and it has to be employed even if the economist is asked to advise subject to some stated political objective, such as national self-sufficiency.

In addition to the system of prescriptions, traditional economics has provided a body of general laws relating to the sequence of events. These have been largely deductive, because they spring from a single simple principle, which has an empirical basis, but one derived from an immensely wide human experience, namely, the law of demand or the law of diminishing utility. This is almost axiomatic, and further investigations are unlikely to reinforce the authority it already has. By the aid of it and of its corollaries, it is possible to derive a theory of supply and demand, by which the effect of specified changes on the course of prices, wages, employment, etc., may in principle be determined. But this law and its corollaries are of very wide generality and consequently are of little use for prediction in any particular circumstances.

To have greater predictory power in this field, it would be necessary to be able to state the laws governing the demand for particular commodities, etc., in quantitative terms. Owing to the plurality of causes, it is extremely difficult to derive such laws from the data of observation. The quantitative laws would certainly be far more conjectural than the general qualitative results derived from the demand axiom. Interesting attempts have been made along these lines. But it is probable that the future of quantitative empirical economics lies elsewhere. Indeed the success of deductive reasoning up to a certain point has probably caused an excessive concentration of effort on this branch of the subject.

The wealth of recommendation, which has characterized past economics, may be reconciled with its paucity of predictory power, when it is appreciated that the power does not rest on the few general causal laws which we have, but on classificatory and survey work.

Contemporary study is seeking new approaches to the establishment of general causal laws, outside the ambit of the traditional laws of demand and supply. It is not yet certain whether greater success is likely to be obtained by the hypothetical-deductive method, which must depend on suitable data being thrown up by the facts of the working world to take the place of the crucial experiment, or by a more radically empirical method, which seeks by constant study and re-classification of the facts to make them speak for themselves and suggest new laws.

In one field at least Mr. Harrod hopes for a further successful outgrowth of deductive theory. The laws of demand and supply, already referred to, which are sometimes known as 'static theory', may be compared with the laws of statics relating to bodies at rest. It should be possible to develop a system of laws, which by analogy may be called dynamic theory, relating to the behaviour of a system when the fundamental magnitudes, population, capital, etc., are increasing (or decreasing). Mr. Harrod suspects that we are on the verge of formulating one or two simple axioms, based on very wide experience and having almost as great an authority as the law of demand in static economics, from which a quite complicated set of laws relating to a system in motion may be derived. Such an axiom may be that people save a larger amount if they have a larger income. Since our society is in fact growing and not stationary, the hypotheses which theorists will be disposed to make in this department will be subject to easier verification than those of static theory.

This is, however, but one out of many possible lines of advance. A greater tendency towards the empirical may safely be predicted. Empirical work in economics is exceedingly laborious, and can only flourish if there is ample endowment for full-time research workers. The branch of statistical theory of especial use to empirical economists is at present displaying a welcome vitality.

Economists should be keenly alive to the findings of workers—sociologists, anthropologists, etc., on the periphery of their subject. But the suggestion recently put forward by one or two eminent persons that economics is in a parlous state requiring salvage by workers in sister subjects is rejected with contempt. Of all the social studies, economics has been most successful in attaining valid general laws of interest and authority, and it is at the moment in a condition in which an advance over a wide front may reasonably be expected.

Changing Outlook of Engineering Science

IN Section G (Engineering), seeking a topic of concern to both practising and academic members of his audience, the president, Prof. R. V. Southwell, undertakes a general stocktaking—to view the trend of engineering science regarded both as an art and as a field for study, teaching and research. He divides his presidential address into three main sections, dealing (1) with policy in regard to the teaching of engineering science, (2) with policy in regard to engineering research, and (3) with 'foreign policy'—the relation of the engineer to the community; its keynote throughout being that in the changing circumstances of to-day engineers, whether practical or academic, must frame their policies in collaboration, not

wait for action to be forced on them by pressure from without.

Among changing circumstances are (1) the trend of modern physics, (2) the attitude of industry towards the university graduate, and (3) the national organization for applied research: each has implications which no engineer can afford to neglect. In regard to the training of university students, which usually occupies five years divided between laboratory and works, he urges the desirability of planning for this period as a whole; and he suggests that university courses are too often overloaded so that insufficient time is left for those divergent pursuits which do most to develop the personal qualities that industry has come to value. Matters appropriate for treatment in the lecture need not necessarily be included in the examination syllabus.

Engineering research, Prof. Southwell believes, will continue to be prosecuted in universities notwithstanding its increasing demand for specialized knowledge of mathematics, physics and chemistry, and the increased provision which now exists in Government institutions and in industrial research departments. Compared with professional physicists, chemists and mathematicians, academic engineers have a special point of view, and one that is needed. Their work will come to approximate more and more to what in the last century was called pure physics: schools of engineering will find problems different from those which engaged their energies a generation ago. When a problem can be turned over to trained men who will work on it full time, it is uneconomic both of brains and of money to pursue it at universities, in occasional spells of leisure from the duties of teaching and administration.

Under his last heading—public relations—Prof. Southwell utters a protest against an implication in much that is written nowadays, that because the range of engineering includes guns, battleships, aeroplanes, tanks, therefore engineers are to be regarded as a class more than others responsible for the horrors of modern war. Wars are not made by engineers but by communities: we all have responsibility, but as citizens and not as specialists. It is vain to talk as though we could have had the benefits of science without its risks and its temptations. Either we must choose, deliberately, impotence as preferable to the power of doing evil, or we must accept knowledge for the double-edged tool it is, vowing to use it wisely.

The Orient and Europe

THE distortions of prehistory on the Continent to fit "biased and distorted political dogmas" and the travesty of the subject broadcast by the B.B.C. a year ago challenge archæologists to justify their membership of an association for the advancement of science by criticizing their hypotheses impartially and objectively in the light of rapidly accumulating concrete facts. Prof. V. Gordon Childe attempts such an examination in his presidential address to Section H (Anthropology).

Prehistory as expounded in Britain rests upon a complex of assumptions, collectively constituting the 'Orientalist position', classically formulated by Montelius in "Der Orient und Europa", published in 1899. His position involved the following assumptions: (1) civilization in the Orient is extremely ancient; (2) civilization can be diffused; (3) elements of civilization were in fact diffused from the Orient to Europe; (4) the diffusion of historically dated Oriental types provides a basis for bringing prehistoric Europe within the framework of historical chronology; (5) prehistoric European cultures are poorer than contemporary Oriental cultures, that is, civilization is later in Europe than in the East.

In 1899, all these propositions had to be treated as axioms. Now systematic excavation in Hither Asia and the Balkans has furnished experimental data by which the foregoing axioms can and must be tested.

(1) Excavations at Erech and Ur, Tel Asmer and Khafaje, Nineveh and Tepe Gawra have dramatically provided concrete proof of the immense antiquity of settled agricultural life in Mesopotamia. Estimated dates of the order of 6000 B.C. for the Tel Halaf phase that is separated from the earliest historical horizons by stupendous accumulations of settlement debris, are at least as plausible as similar geological estimates of the age of the North European mesolithic. Similarly, excavations at Alişar Hüyük, Troy and Thermi have vindicated the antiquity of metal-using cultures in Anatolia too.

(2) The exploration of Anatolia has also provided fresh evidence for cultural connexions with Mesopotamia. Taken in conjunction therewith, Heurtley's work in Macedonia has established irreversibly the Anatolian origin of the Macedonian Early Bronze Age culture. At the same time the 'Late Neolithic' culture, that immediately precedes and may partly overlap it, proves to be, to all intents and purposes, identical with that revealed at Vinča and other sites in the south-east of the Middle Danube basin. Thence culture is well known to be continuous right up to the Rhine, whither Mediterranean *Spondylus* shells were imported even in the first neolithic period or Danubian I. A cultural continuum can now be traced from the Tigris to the Rhine and affords opportunities for the diffusion assumed in axiom (2).

(3) Oriental prototypes for arbitrary forms of

personal ornament, distinctive of the Early Bronze Age of Central Europe, have been multiplied surprisingly during the last five years. Ingot-torques, lockrings and ear-rings with flattened ends, scroll, knot-headed and racquet pins are now all known from Mesopotamia.

(4) In Mesopotamia, however, all these types emerge unexpectedly early. The *terminus post quem* for the beginning of the Central European Bronze Age or Danubian IV is accordingly nearer 2800 than 1800 B.C. Moreover, types distinctive of previous phases of European prehistory have come to light in still earlier contexts in the Orient; battle-axes, for example, such as belong to Danubian III, can be traced back to the Uruk or even the al'Ubaid phase in Mesopotamia. Still adhering to a strict application of axiom (4), we can raise the absolute dates attributed to the several phases of the New Stone Age in Europe to meet the estimates of botanists and geologists.

(5) Even so, axiom (5) would remain intact. At the beginning of the Central European Bronze Age about 2800 B.C., we should survey a cultural continuum over which we descend by regular gradations from the great cities of Egypt and Mesopotamia with their fully literate civilization through Anatolian and Ægean townships of illiterate, but metal-using communities, to Central European villages where metal was virtually restricted to weapons and ornaments, neolithic hamlets in North Germany and Denmark and pure food-gatherers farther north. At the beginning of the European neolithic period, a couple of millennia earlier, similar relations would hold good: a chalcolithic Assyrian township like Arpachiya would have to be compared to a self-sufficing temporary hamlet of twenty households like Köln-Lindenthal, while the boundaries of food-gatherers would be extended southward to the edge of the loess in South and Central Germany.

Even on such a maximal chronology, the orientalist position remains unassailable. But that chronology has been advanced only tentatively to see how archæological deductions fit the hypotheses of other disciplines. It need not be accepted as even plausible unless geologists and botanists become more unanimous and confident.

Eye and Brain as Factors in Visual Perception

IN his presidential address to Section J (Psychology), Dr. R. H. Thouless deals with the implications for the theory of visual perception of the fact that the physiological mechanism of vision is not only the retinal surface but also the whole system which includes retina, optic nerve, visual area of the cortex, and to some extent, other sensory areas of the brain as well.

It was assumed in much of the earlier work in vision (as in that of Helmholtz) that the basic process in vision is the formation of an optical image on the retina and its transmission to the visual centres of the brain by means of the optic nerve. Differences between the sensations transmitted to the brain and the finished perception were attributed to the action of the higher processes of judgment and the influence of past experience. This may be called the 'transmission theory' of vision. Within a certain limited field—that of the sensory physiology of the retina—it proved itself a fruitful guide to research. Modern researches on visual perception have, however, now made it clear that the transmission theory is wrong, and that a wholly different way of approaching the problems of visual perception is necessary if we are not to be led astray.

The modern attack on the transmission theory started from Wertheimer's experiments on the so-called 'phi-movement' which is seen when two retinal points are successively stimulated at certain time intervals. This is one of many known examples of the appearance in perception of something which does not exist in the pattern of stimulation.

The same conclusions may be reached by a study of the apparent shape of an inclined object. This apparent shape is not identical with the retinal shape but lies between this and the real shape. Careful consideration of this experiment makes untenable the view that the retinal shape is given as 'sensation', which is modified by a process of 'perceptual judgment'. There is no evidence that the 'sensation' is in any way an ingredient of the experienced shape. Rather the experienced shape appears to be a direct product of both the shape of retinal stimulation and of such perceptual cues as indicate the real shape of the object.

Individual differences are characteristic of the cerebral side of perception. Although the optical system of the eye may not differ much in different individuals, their perceptual responses may be very different. The amount of "phenomenal regression to the 'real' characters of objects" (that is, the extent to which apparent shape, size, and brightness are determined by the real shapes, sizes and brightnesses of objects, irrespective of inclination, distance, and illumination respectively) differs widely from one individual to another. These differences are not generally suspected until they are shown by experiment. The measurements of any one individual, on the other hand, show high self-consistency, even when the period between two measurements is as long as two years.

These differences are not merely of interest to

scientific curiosity; they may also have practical consequences. Research has confirmed the prediction (originally made on theoretical grounds) that a high tendency to see objects in their real sizes irrespective of distance should be of advantage to the drivers of motor vehicles. The amount of this tendency may be altered by the action of drugs and by the presence of mist and fog, and this change may affect driving. One case has been reported of its change in a neurotic condition.

The psychology of vision can no longer be treated as if vision were a function of the eye alone. The foundations of a psychology of vision were firmly laid by the work of Helmholtz and his contemporaries, who made a scientific study of the sensory physiology of the eye. The most fruitful field of research at present is in those wider problems of visual perception in which the eye and the higher centres co-operate.

Physiology of the Plant Cell

PROF. W. STILES, in his presidential address to Section K (Botany), defines the general physiology of the plant cell as those vital activities of plants which are manifested by every living cell, and are thus distinguished from those special processes such as photosynthesis, which are restricted to certain specialized organs. These general activities of living matter are respiration and the absorption and excretion of water and dissolved substances.

The usually accepted meaning of respiration is that it provides the energy for plant movements and the building up from the products of photosynthesis of substances of higher energy content than these products. Yet as respiration is a constant property of living matter, even when there is no movement and no formation of fresh material it may be questioned whether this current view of respiration is complete. As regards the synthesis of proteins and other complex substances, while there is evidence of the linkage of anabolic processes with the breaking down of carbohydrate, this anabolism only concerns the re-formation of carbohydrates, and no evidence has yet been obtained which sheds any light on the way in which energy released in respiration is transferred to the processes involved in the synthesis of proteins and other substances of higher complexity than those forming the respiratory substrate.

The absorption of water and dissolved substances by plant cells was formerly assumed to be a simple process of diffusion through cell membranes, but during the present century experimental work has shown that while the absorption of non-electrolytes may sometimes take place in this way, the absorption of electrolytes is a much more complex process, for the unequal absorption of the two ions of a salt, and the entrance of the ions of a salt against their own concentration gradients are very general phenomena. Theories based on adsorption and interchange of ions have been put forward to account for these observed facts, but while such processes probably operate, it is doubtful whether they afford a complete explanation of the phenomena.

The connexion between respiration and the salt relations of tissues was pointed out in 1927, and since then further evidence has been forthcoming which has emphasized the connexion between respiration and the diffusion of salts into plant cells against the concentration gradient. The energy required for the entrance of salt thus is presumably provided by respiration, and theories have been enunciated which regard the absorption of ions as a continuous interchange of the former with the hydrogen and bicarbonate ions continuously produced within the cell as a consequence of respiration. While this interchange may be a factor in salt accumulation, there is evidence that the connexion between respiration and accumulation is generally much more indirect, and that the failure of cells to accumulate salt when respiration is lowered through deprivation of the cells of an adequate oxygen supply is related to their generally lowered vitality under this condition.

It is emphasized that salt accumulation, like respiration itself, is a vital process dependent on the protoplasm, while there is some evidence that in the absorption of water by the plant cell, there is in some, though not all, cases an active secretion of water. It is thus clear that a further analysis of the protoplasmic system is necessary for a better understanding of general cell physiology.

The general physiology of the cell is not only of fundamental importance for plant physiology in general, but it is of similar importance for all ecological investigation which is not merely descriptive, while it also impinges on the important fields of mycology and cyto-genetics. Cell physiology is the scientific basis of many important plant industries, including those of food preservation and storage.

Administration of Public Education

IN his presidential address to Section L (Education) Mr. John Sargent discusses the part which administration, and local administration in particular, ought to play as a medium through which the basic principles of educational science, as revealed either by *a priori* reasoning or as the

result of research and experiment, may be translated into action so far as the public system of education is concerned.

Attention is directed in the first instance to a change during the last century in the conception of the function of government which has exercised a profound influence on the whole theory and practice of administration. This transition is from the idea of the State as essentially a policeman to that of an active promoter and provider of facilities for enabling all citizens to live fuller and happier lives. This change of conception as to function is connected with the abandonment in favour of the idea of human progress of the Platonic principle that any social and political order, however perfect, is bound sooner or later to decay. It is clear that both the nature and the aims of an administrative system which is inspired by the belief that it can and should assist individuals along the road to perfectibility will differ fundamentally from those of one which only hopes to postpone inevitable decay.

The consequence of regarding the State as some kind of universal provider has been a vast increase in the legislative activities of government and has led in turn to greatly increased devolution of executive functions from the central to the local authority. An examination of the capacity of the present local education authorities to cope with their continually increasing burden reveals certain defects, many of which derive from the historical and traditional considerations which have determined the boundaries of English units of local government. In brief, the main defects from which local education authorities appear to be suffering are inherent in their large number and in the great variety in their sizes, resources and the powers delegated to them; the result being possibilities of overlapping, friction and in many cases of almost intolerable financial strain. It is admitted that some of these difficulties are being successfully overcome by co-operation, but co-operation of itself cannot be regarded as an ideal method of administration.

A more serious defect, arising from the same set of circumstances, lies in the increasing difficulty in securing men and women with the necessary time and intelligence to devote to the business of local government. This applies particularly to the unpaid partners in the administrative system. The increase in the demands which the business of local government makes on the time of members of authorities, and the parallel increase in similar demands arising from earning a livelihood, are working together to deprive local bodies of the services of persons in the prime of life and actively engaged in industry and commerce. The type of disinterested administrator on whom local government was able to rely a generation ago is steadily dying out.

It is recognized that any attempt to remedy these defects may involve changes in the traditional boundaries of local government areas, and would certainly bring the reformer up against that formidable factor known as local patriotism. It is, however, suggested that fewer authorities, with areas and powers more uniform than at present, would not only simplify the problems of administration but would also widen the choice so far as personnel is concerned. A further suggestion is that consideration might be given to modifying the duties performed respectively by members of the committees and their officials with the view of reducing the present calls on the time of the former. Failing this, the only alternative would appear to be to attempt to counteract any deterioration in the amateur element by raising the standard of the professional, although it is realized that any development along these lines would raise a natural suspicion of undue bureaucratic control and would need adequate safeguards in this respect.

A Long-Term Agricultural Policy

PROF. R. G. STAPLETON, in his presidential address to Section M (Agriculture), stresses the importance of ley-farming in relation to the present-day needs of the nation, and in general he discusses the bearing of systems of farming on the formulation of a long-term agricultural policy. He urges that the needs of the nation must be made to govern the activities of the farmer. In considering national need, it is pointed out that account must be taken of future contingencies, as well as of present requirements. Thus, as well as producing an abundant supply of fresh food, our agricultural policy must take heed of war danger, fall in the population, and the influences of soil erosion overseas. The essential matter is therefore to maintain our acres in a fertile condition, while it is also desirable that we should conduct our farming in such a way as to make possible the maximum of flexibility in commodity production, and to make ourselves altogether less dependent upon imported feeding stuffs.

The main features of the arable, permanent grass, nondescript (much permanent grass and a little arable land per farm) and ley systems are outlined, and it is shown that the arable and ley systems are those which accord best with national needs. Permanent grass allows of the minimum of flexibility, and does not afford the best means of turning grass as such to the most

profitable account. By adopting alternate husbandry (ley-farming) it is possible to lime land under the plough, which is always the correct way to apply lime, to maintain the fields of the farm in maximum fertility, and to cash the fertility by means that are not wasteful.

Technical details governing the establishment and management of leys for different purposes are considered in some detail, and finally Prof. Stapledon considers the action that is necessary in order in the first place that the present condition of our acres may be accurately gauged, and in the second place, to hasten forward the ploughing up of land in permanent grass that is capable of being used to better advantage. He emphasizes the necessity of conducting a proper survey on a uniform basis on the land itself, particular attention being given to the classification of the acreage in permanent grass and in rough grazings.

The crucial difficulties standing in the way of ploughing up are lack of facilities and lack of working capital. A strong case is made for the extension of credit facilities granted for the explicit purpose of ploughing up and other contingent improvements. It is urged, however, that credit facilities should only be given to carefully selected farmers, and then only to those who will contract to work to an agreed plan over a sufficiently long run of years. Apart from credit facilities, much might be achieved by a re-orientation in the financial and other arrangements made between landlords and tenants, and it is urged that ley-farming, if it became more general, would make it possible to adopt a variety of systems of share farming in directions not at present feasible.

National Parks and the Preservation of the Flora and Fauna of Great Britain

IN his presidential address to the Conference of Delegates of Corresponding Societies on the use of national parks in Great Britain for the preservation of the fauna, Lord Onslow points out that the term 'national park' covers any natural reserve or open space to which the public have access regardless as to whether it is to be devoted to the preservation of fauna and flora or not, and Lord Onslow discusses methods of utilization of such national parks. The question of the desirability of re-introducing and acclimatizing animals now extinct in Great Britain, such as the reindeer, wild pig, beaver, Irish stoat and lemming, has also to be considered.

Granting the desirability of creating a national park in Great Britain, the first consideration is where to put it. The west coast of Scotland seems to be an ideal spot for such a venture. In those counties there exist thousands of acres of deer forest land, which lends itself readily to the creation of a national park. Such a forest already contains a considerable number of the animals which it is sought to preserve and it may be hoped that others could be acclimatized there. Probably the most attractive animals in a park will be the deer. In Great Britain there are three species of deer—red deer, roe deer, fallow deer. Whether the latter is actually indigenous or was imported at some remote period has not been decided, but if they are not really wild animals, they exist all over the country in a feral state. Other beasts which might well be added to the stock of a national park are the so-called park cattle. These, as is well known, exist in a wild state at Lord Tankerville's estate at Chillingham. The Chartley and Cadzow herds strongly resemble the Chillingham ; a herd of these cattle allowed to exist in a wild state would prove a valuable addition to a national park. Then in Scotland there are a few wild goats, which might well be preserved in a national park. Perhaps the most interesting animals would be the carnivorous animals. Foxes, badgers, stoats and weasels are common enough and exist in Scotland as well as in England and Wales. There would be no difficulty about them nor would there be about otters, provided, of course, the park had streams, rivers and burns to provide fish. But there are three species which are becoming very scarce indeed, and deserve every effort being made to retain. These are the wild cat, the pine marten and the pole cat. Perhaps the most difficult beasts to acclimatize in Scotland would be the rarer bats, most of which have only been found in the south of England. Rodents are common enough, so their preservation would present no difficulties.

Turning from mammals to the birds, one may say that if birds are unmolested, generally speaking they will be present, at least those which are suitable to the district. The national park should form a strict bird sanctuary, and if possible part of the park should be near the sea so that sea birds could be encouraged to breed there.

As regards finance, forest country in Scotland is now cheaper than it used to be, and it should be possible to acquire the necessary land for the public generally, either under the Government or by means of public subscription. A national park would not be so expensive to maintain as a deer forest. In the first place there would be an income coming in, as there is in the National Kruger Park, which makes quite a handsome income. There would have to be a hotel or rest house, and roads and footpaths would have to be made so that people could get about and see the animals.

As regards staff in the park itself, the number employed would probably not be great as in the average deer forest.

The method of management of a national park in Scotland has been ably discussed by Sir Peter Chalmers Mitchell. He would put the arrangements for its popular functions in the hands of delegates appointed by Edinburgh, Glasgow, Dundee and Aberdeen, working with delegates appointed by the council or councils of the county or counties in which the park was situated. He would add to the governing body of the national park a panel of persons selected for their special knowledge of wild Nature in all its aspects. At least one botanist, one zoologist, one geologist, and two 'field naturalists', one with special knowledge of plants, the other an ornithologist. He thinks these might be selected by the principals of the four Scottish Universities, and the presidents of the Royal Society of Edinburgh and of the Highland and Agricultural Society. Moreover, apart from the staff concerned with the general regulation of the park, there should be one warden or ranger selected by the naturalist panel, whose sole duty should be the constant study of wild life in the park and all its fluctuations.

PRINTED IN GREAT BRITAIN BY FISHER, KNIGHT AND CO., LTD., ST. ALBANS

beneficial earthquake, but one such was reported from Cannes by *The Times* correspondent on July 29. An earthquake shock near the village of Réotier in the Hautes Alpes has removed an obstruction to the water supply which experts for many years have been trying to locate. The village fountain, dry for many generations, is now gushing forth water and the acute water shortage is at an end. On August 13, a small earth tremor was felt at Pwllheli in Wales, but no damage was done. It was probably due to subsidence in underground mine workings.

Scientific Survey of the Cambridge District

WHILE those who are visiting Cambridge for the first time—and indeed many who are re-visiting their *Alma Mater*—will have found the little "Concise Guide to the Town and University of Cambridge", originally written by John Willis Clark, of the utmost value and interest, an even wider audience will have welcomed the book "A Scientific Survey of the Cambridge District" specially prepared for the meeting by the local committee in Cambridge and edited by Dr. H. C. Darby. In fifteen chapters, the geology, physiography, climate, biology and history of Cambridge and the Fen District are summarized by specialists, with numerous references to the literature, and with appropriate maps and diagrams. In particular, there are, as would be expected, chapters on the drainage of the Fens and on the Breckland. The fact that this customary survey of the *venue* of the meeting is now sent out to members a week or so before the meeting opens gives the scientific worker time to learn in advance of the local topics and places likely to be of especial interest to him. The Survey is to be printed as usual in the Annual Report, and additional copies are also on sale (price 2*s*.).

The Darwin Library at Down House

THERE is at present a small collection of books, etc., known as the Darwin Library, at Down House, Downe, Kent, the home of Darwin from 1842 until 1882, which is now in the hands of the British Association. The major part of the existing collection consists of Darwin's own library, which belongs to the professor of botany in Cambridge for the time being, and was generously replaced in Down House by Sir Albert Seward during his tenure of that chair, an action confirmed by his successor, Prof. F. T. Brooks. For the rest, the number of Darwinian books in the possession of the Association is not large; whereas inquiries concerning such books are not infrequently made by visitors and others. The Down House Committee of the Association is endeavouring to collect (*a*) all biographies of Darwin; (*b*) contemporary works on Darwinian theories and kindred subjects; further (*c*) the collection of Darwin's own publications (books and papers) is not complete; and (*d*) the Committee would gladly receive and preserve contemporary reviews of Darwin's works. Those who may be in a position to offer appropriate books or papers are asked, in the first instance, to communicate particulars thereof to the Secretary, British Association, Down House, Downe, Kent, in order that duplication may be avoided.

German Trans-Atlantic Flight

THE four-engined German monoplane *Brandenburg* landed at the Floyd Bennett Field, New York, at 15.54 (New York time) on August 11 after the first successful non-stop flight from Berlin. The time taken for the 3,942 miles' flight was a little more than twenty-five hours. The machine flew over Newfoundland and the Gulf of St. Lawrence, and at noon passed over St. John, New Brunswick. She encountered head-winds coming down the coast from Canada, and was flying at a height of 2,000 ft. at 155 miles an hour. The return flight was completed successfully on August 14 in just under twenty hours. The machine is said to have room for twenty-six passengers, and the flight was designed to show the feasibility of commercial non-stop travel between Germany and America. It is an all-metal monoplane with a wing-spread of 108 ft., it carries four 720-h.p. engines, and has a cruising speed of 196 m.p.h.

International Geological Congress

AT the seventeenth session of the International Geological Congress held in Moscow in 1937, the Geological Society of London extended an invitation, which was accepted, to hold the eighteenth session of the Congress in London in 1940. The first circular, which has just come to hand, contains preliminary details of the arrangements proposed. These include sessional meetings in London on July 31–August 8, 1940, and an attractive programme of excursions—always an important and valuable feature of Congress activity—which will cover most of the important geology of Great Britain and Eire, and will afford the members of the Congress unrivalled opportunity of visiting many of the type-localities under expert guidance. A provisional list of fourteen subjects for discussion at the actual sessional meetings in London is given in the circular. Among these we may note magmatic differentiation, the geology of iron ore deposits, the geology of coal seams, the geology of petroleum, the distribution of early vertebrates, earth movements and evolution, the geological results of applied geophysics and the geology of sea and ocean floors. The organizing committee, mindful of the fact that this important Congress has not met in Great Britain since 1888, is anxious that the arrangements for the meeting in 1940 shall be as widely known and complete as possible. The office and headquarters of the Congress are at the Geological Survey and Museum, Exhibition Road, London, S.W.7, and all communications should be addressed to the general secretaries at that address.

Agricultural Research Scholarships and Awards

ON the recommendation of the Agricultural Research Council, the following awards of agricultural research scholarships, studentships for research in animal health and veterinary scholarships have been made by the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland: Dr. R. E. Taylor (King's College, Newcastle-upon-Tyne) a three-year research scholarship in plant pathology, the first year to be spent at Cambridge;

I. F. Storey (Victoria University, Manchester, and the Imperial College of Science and Technology) a one-year research scholarship in plant pathology at the Imperial College; D. C. Thomas (Imperial College of Science and Technology) a two-year research scholarship in entomology, the first year to be spent at Cambridge; G. W. Cooke (University College, Nottingham) a three-year research scholarship in soil chemistry, the first year to be spent at the Rothamsted Experimental Station; M. R. F. Ashworth (Oriel College, Oxford) a one-year research scholarship in soil chemistry at the Macaulay Institute for Soil Research; D. J. Finney (Clare College, Cambridge) a two-year research scholarship in agricultural statistics, the first year to be spent at University College, London; A. N. Worden (Royal Veterinary College, Camden Town) a three-year studentship in animal health, the first period to be spent at the Lister Institute; J. A. Campbell (Downing College, Cambridge) a four-year veterinary scholarship at the Royal Veterinary College, Camden Town; J. L. McGirr (University of Glasgow) a four-year veterinary scholarship at the Royal Veterinary College, Camden Town. The object of these research scholarships and studentships is to train research workers in agricultural science and the science of animal health, and, in the case of the veterinary scholarships, to enable graduates with honours in science to obtain a veterinary professional qualification, with the view of undertaking research in animal health. This year for the first time two veterinary scholarships have been awarded.

Announcements

MR. HUGH LETT, consulting surgeon to the London Hospital, has been elected president of the Royal College of Surgeons of England.

MR. SYDNEY A. HURREN, head of the Department of Radio Technology at the Northern Polytechnic, has been nominated, for the third year in succession, for election as president of the Institute of Wireless Technology.

A NEW Institute for Atomic Physics has been inaugurated at the Royal Hungarian University for Technical and Economic Sciences, and Prof. Z. Bay, formerly professor of theoretical physics in the University of Szeged, at present director of the Tungsram Research Laboratory of the United Incandescent Lamp and Electrical Co., has been appointed the first professor of atomic physics.

IN NATURE of August 13, p. 287, reference was made to a record crossing of the Atlantic from east to west by the *Queen Mary*. On the return voyage, completed on August 14, another record was set up; the *Queen Mary's* time for the distance from the Ambrose Channel lightship to the Bishop Rock was 20 hr. 42 min., and her average speed 31·69 knots.

THE Metro-Goldwyn-Mayer Corporation is to produce a film of the life of Mme. Marie Curie early next year. Mr. Aldous Huxley will prepare the scenario for the film from an account of Mme. Curie's life written by her daughter, Mlle. Eve Curie. It will be recalled that Mlle. Eve Curie was the author of the book entitled "Madame Curie" published this year (see NATURE of June 18, p. 1079). Miss Greta Garbo has agreed to play the part of Mme. Curie.

A VALUABLE addition to the collection of statuettes of pioneers of the British Empire in the Imperial Institute, South Kensington, is the figure of David Livingstone (1813–1873), which has been placed in the Northern Rhodesian Court. The cost of the statuette has been defrayed by the Northern Rhodesian Government, to whom a replica is being sent to Livingstone. This statuette, like those of Cabot, Van Riebeeck, Raffles and Brooke, which immediately preceded it in the collection, is a bronze of half life-size, and the work of Mr. Herbert H. Cawood, of Sheffield.

A FRANCO-CZECHOSLOVAK MEDICAL CONGRESS will be held at Prague on September 15–17. Further information can be obtained from the general secretary, M. A. Ravina, 254 faubourg Saint-Martin, Paris.

THE fifty-first Annual Conference of the Sanitary Inspectors' Association will be held at Edinburgh on September 5–10 under the presidency of Sir Leonard Hill. The subjects for discussion will include shell-fish, inspection of meat, laboratory control of the milk supply, food and drugs legislation, housing, sanitation, atmospheric pollution, the disposal of trade effluents, and a comparison of English and Scottish sanitary practice. Further information can be obtained from the Secretary, 19 Grosvenor Place, London, S.W.1.

THE thirteenth Italian Congress of Occupational Diseases will be held at Bari under the presidency of Prof. L. Ferrannini on September 10–12, when the following subjects, among others, will be discussed: occupational pathology of aviation; occupational pathology of athletics; adaptability of the Italian workman to the climate of East Africa; results of the application of compulsory insurance against occupational diseases in the first four years. Further information can be obtained from the Secretary, R. Clinica Medica, Bari, Italy.

THE Association for Education in Citizenship is arranging two conferences during October. A conference at Birmingham will discuss "The Meaning of Citizenship", and will be held at the University on October 8–10. Mr. Anthony Eden, M.P., and Sir Norman Angell are among the speakers. The second conference will be at Bristol, on "Education for Democracy and the Modern World", on October 14–16. Lord Allen will give the introductory speech on "Democracy—Britain's Need of a Political Religion", and among other speakers are Miss Rathbone, M.P., Prof. N. F. Hall, John Bell, Gordon Barry, W. McG. Eagar and Harold Shearman. Further information can be obtained from the Secretary at the Association's offices, 10 Victoria Street, S.W.1.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 360.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Reflection of Atmospherics by the Ionosphere

IN a previous letter to NATURE[1], evidence was given that some atmospherics are reflected at the ionosphere. Further oscillographs obtained with an improved technique (see Figs. 1 and 2—photographic records on a rapidly moving film of the electric field of atmospherics) have led us to the conclusion that all atmospherics are reflected at the ionosphere. The electrical discharge, which appears to be lightning in all the observations we have made, radiates an electromagnetic disturbance which is propagated as a ground wave, and as a series of sky waves, which are reflected 1, 2 . . . n times at an ionized layer at a height h km. Assuming the velocity of all the waves is that of light, and that the sky waves are optically reflected, then the intervals of time between the arrival of the ground wave and of the sky waves are given by the expression stated in the previous communication[1].

When an oscillogram enables the times of the arrival of the ground wave and of the first, second . . . nth sky waves to be determined without ambiguity (Fig. 1 is such an oscillogram) the application of this expression is straightforward.

In the case of many oscillograms, before the identification of the sky waves is possible, an assumption needs to be made as to whether the electrical discharge is periodic or aperiodic, and whether the electromagnetic disturbance which it radiates is a damped wave or a single pulse. Fig. 2 is one of seven almost identical oscillograms observed during a period of 12 minutes. We interpret these oscillograms as being due to an oscillating disturbance of five half-periods, the first three half-oscillations being undamped, and the fourth and fifth damped. Further, the sky wave once reflected at a height of 95 km. arrived 470 μsec. after the ground wave and came from a thunderstorm which was known to be at a

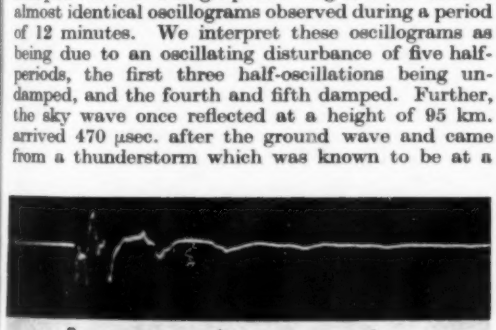


Fig. 1.

A DAMPED WAVE WITH A SERIES OF REFLECTED WAVES. TIME, 0115; d, 190 KM.; h, 88 KM.; E, 1·14 $V./m$.

distance (d km.) of 70 km. The value of the observed maximum electric field-strength agrees with this distance. This sky wave arrives at an angle of 20° to the vertical and it is emitted at the same angle. If the radiator is a vertical lightning flash the intensity of this wave will be proportional to sin 20°, and thus the intensity of reflected waves from near sources is small.

If the disturbance (on the other hypothesis) is a single pulse, then there are sky waves reflected

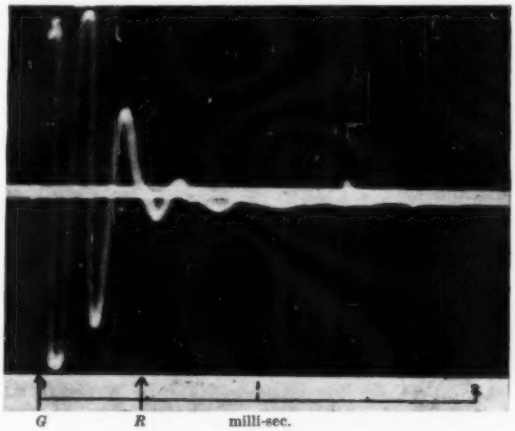


Fig. 2.

A DAMPED WAVE WITH REFLECTED WAVE ARRIVING 0·47 M.SEC. AFTER THE GROUND WAVE. TIME, 1347; d, 70 KM.; h, 95 KM.; E, 3·30 $V./m$.

once, twice . . . 7 times at a height of 56 km. from a source distant 290 km. Actually no evidence of lightning at that distance exists, and the observed maximum field strength is too large for such a distant storm.

A characteristic of the observed oscillograms is that all those taken within a short interval of time, and probably from the same thunderstorm, are closely similar in form. This is attributed, not to some constant characteristic of the storm itself, but to the fact that since a storm is usually of small extent, d and h would remain approximately constant for the periods of time in question, and that this observed fact means that d and h mainly determine the character of an oscillogram.

Date	Time	n	h	d
Feb. 20, 1937	0115	7	88	190
Feb. 27, 1937	1104	6	59	200
Feb. 20, 1937	0130	7	88	340
Feb. 20, 1937	0145	6	88	350
Feb. 4, 1937	1525	7	67	390
Nov. 6, 1937	1700	7	86	470

The accompanying table contains the values of h and d calculated from oscillograms for which a

satisfactory identification of the arrival of the sky waves has been made.

The equivalent wave-length of an atmospheric may be taken as 17,000–40,000 m. The values of h in the table mean that if 100 km. is the height of the E layer, the conditions of ionization and collision frequency required for the reflection of long waves exist in the upper atmosphere 10–30 km. below the boundary of the E layer as determined by the reflection of short waves. We have sought for evidence of a D or lower ionized layer, but have found none. (If an atmospheric at its source is a single pulse then, as stated above, Fig. 2 could be interpreted as evidence of the existence of low layers, but the balance of evidence, we think, does not support this interpretation.)

An accepted expression for the attenuation of long waves propagated along the ground makes $E.d$ constant, where $E\,v/m$ is the field strength at a distance d km. from an electromagnetic radiator of constant power. $E.d$ is found to range in our atmospheric observations from 170 to 350. This agrees with evidence previously found by C. T. R. Wilson[3], Munro and Huxley[3], Boswell and Wark[4], that a lightning flash does not vary greatly in its initial electric moment and in its radiating power.

In the observations discussed above, the electrical discharge was 70 km. or more from the observing instruments.

T. H. LABY.
F. G. NICHOLLS.
A. F. B. NICKSON.
J. J. MCNEILL.

Natural Philosophy Laboratory,
Melbourne University,
Melbourne, N.3.
June 22.

[1] Laby, T. H., Nicholls, F. G., Nickson, A. F. B., and Webster, H. C., NATURE, 139, 837 (1937).
[2] Wilson, C. T. R., *Phil. Trans. Roy. Soc.*, A, 221, 73 (1920).
[3] Munro, G., and Huxley, L. G. H., *Rept. Aust. R. R. Bd.*, No. 5 (1932).
[4] Boswell, R. W., and Wark, W. J., *Quart. J. Roy. Met. Soc.*, 62, 499 (1936).

Time and Probability

TIME has recently been the subject of much discussion. More than a year ago my colleague, Dr. F. L. Arnot, in connexion with a cosmological theory summarized in NATURE of June 25, directed my attention to the relation between kinematic or atomic time, t, and planetary or pendulum time, τ. This may be expressed in the formula

$$\tau = t_0 \log\,(t/t_0) + t_0,$$

t_0 being a constant of integration representing "the present age of the universe at ourselves, reckoned on the t-scale" (Milne).

The use of a logarithmic time scale was suggested by de Sitter in 1933, but the further development of such a scale is mainly due to E. A. Milne. Although Milne speaks of t as "probability time" (1937), this aspect of the time scale does not seem to have attracted much attention, and it is the object of this letter to stress the close relationship between time *as measured* and probability.

Boltzmann's formula

$$S - S_0 = k \log\,(W/W_0),$$

connecting entropy S and "probability" W, is similar in form to that which connects de Sitter's two varieties of time. The entropy formula "corresponds with the fact that entropies are additive and probabilities multiplicative. When a system moves into a more probable state, its entropy is increased and its probability is multiplied by a factor" (Ubbelhode).

The mathematical resemblance between the time formula and the entropy formula is an indication of the fact that kinematic time t may be interpreted as a "probability", and consequently time as measured by an astronomer or physicist is a statistical quantity. Illustrations of this statistical interpretation are not difficult to find. In using a sand glass we may be able to detect on close examination the motion of individual grains of sand, but we note the passage of time by observing the fall of an assemblage of grains. We are dealing with a statistical result and assume that on the average the time taken for the total quantity of sand to pass is the same in successive operations of the hour glass. In the water clock, or clepsydra, the same principle is applicable, but the moving particles are of smaller dimensions. When a 'rigid' body, a pendulum or rotating planet, is used for the measurement of time, we are again concerned, from the point of view of atomic or molecular theory, with a statistical result.

Eddington's picturesque description of entropy as "time's arrow" need not be taken too seriously. In "Philosophy and the Physicists", Stebbing has taken objection to the view that entropy may be regarded as "the signpost of time". The experimenter must be aware of the order of his observations before he can draw conclusions from them. In the majority of his experiments, he is dealing with statistical results. The familiar phrase "the tide of time" is in some measure suggestive of a statistical interpretation of time.

H. S. ALLEN.

The University,
St. Andrews.
July 21.

Cosmological and Atomic Constants

IN view of some recent contributions[1] it may be considered not altogether useless to point out a few more relations (or 'coincidences') between some fundamental magnitudes that occur in astrophysical theory and very large dimensionless numbers that can be constructed from atomic constants and the constant of universal gravitation G. If γ_1 and γ_2 represent the large numbers constructed from (e, c, m_H, G) and $(\hbar, c, m_H, G)$ respectively, then

$$\gamma_1 = \frac{e^2}{m_H{}^2 G} \sim 1{\cdot}23 \times 10^{36};\ \gamma_2 = \frac{\hbar c}{m_H{}^2 G} \sim 1{\cdot}87 \times 10^{39} \quad (1)$$

$$\text{and } \alpha \equiv \frac{\gamma_2}{\gamma_1} = \frac{\hbar c}{e^2} \sim 137,$$

where $\hbar$ is Planck's constant (multiplied by $1/2\pi$), c the velocity of light, e the electron charge, m_H the mass of the proton, and m the mass of the electron.

It is known[2] that the usual theory of the white dwarf stars, when combined with the theory of pressure ionization, predicts a maximum radius for a cold body, that is, a stellar mass composed of matter degenerate in the sense of Fermi-Dirac statistics. Let $R_{\max.}$ denote this maximum value of the radius and M_0 the corresponding mass, then it is interesting to note that the large (astrophysical) dimensionless numbers M_0/M_H and $R_{\max.}/\left(\frac{\hbar}{mc}\right)$ which we can construct from the fundamental magnitudes M_0 and $R_{\max.}$ are very simply related to γ_1 and γ_2.

In fact, apart from numerical factors of order not far different from unity, the theoretical expressions for $R_{max.}$ and M_0 show that

$$\frac{M_0}{M_H} \simeq \gamma_1^{3/2} \sim 10^{-3} \odot, \quad \frac{R_{max.}}{\frac{\hbar}{mc}} \simeq \alpha^{1/2}\gamma_2^{1/2} \sim 0{\cdot}1\, R_\odot, \qquad (2)$$

where $\odot$ is the mass of the sun, $R_\odot$ its radius. Further, if M_1 denotes the (Chandrasekhar–Stoner)[3] upper-limit to the mass of the completely degenerate configuration, then again apart from numerical factors

$$M_1/M_H \simeq \gamma_2^{3/2}, \quad \ldots \ldots \ldots \qquad (3)$$

a 'coincidence' which has already been pointed out by Chandrasekhar. It is interesting to see that

$$\frac{M_0}{M_1} \simeq \left(\frac{\gamma_1}{\gamma_2}\right)^{3/2} = \alpha^{3/2} \quad \ldots \ldots \ldots \qquad (4)$$

It will be observed, as has been noted by Chandrasekhar (though in a slightly different form) that if the power of γ_2 be taken not as $\frac{3}{2}$ but $\frac{3}{2} + \frac{1}{2}$ and $\frac{3}{2} + \frac{1}{4}$, it gives (roughly) the order of the number of particles in a galaxy and the 'universe' respectively.

It may be further pointed out that if γ_2 in (2) be similarly given powers of $\frac{1}{2}$, $\frac{1}{2} + \frac{1}{2}$ and $\frac{1}{2} + \frac{1}{4}$, we obtain the order of the maximum radius for a *cold* body (roughly) the radius of a galaxy and the Universe respectively.

The time-dependence of γ_1 and γ_2 according to the ideas of Dirac and Milne will be reflected in a corresponding time-dependence of M_0 and $R_{max.}$[5] and other astrophysical magnitudes.

D. S. KOTHARI.

Physics Department,
University of Delhi.
July 9.

[1] Dirac, *Proc. Roy. Soc.*, A, **165**, 199 (1938); Chandrasekhar, NATURE, **139**, 757 (1937); Schrödinger, NATURE, **141**, 410 (1938).
[2] Kothari, *Proc. Roy. Soc.*, *A*, **165**, 486 (1938).
[3] Chandrasekhar, *Mon. Not. Roy. Astro. Soc.*, **91**, 456 (1931).

Interference Patterns with Liesegang Rings

ANYONE who is experimentally familiar with the production of Liesegang rings in gelatine films and other allied phenomena might well feel tempted to believe that such periodical precipitates are to be regarded as wave-patterns. Indeed, several workers in the field appear to have felt that the analogy between the Liesegang phenomenon and a wave-effect is not merely superficial, and have sought for more positive evidence in support of it. Leduc and others, for example, claimed that Huygens' well-known optical principle gives an explanation of the form of the rings observed when a precipitating agent diffuses through a narrow aperture in an obstacle cutting across the film. More recently, some Russian workers[1] have gone further and suggested that the periodic precipitation itself is to be explained in terms of the de Broglie waves associated with the movement of the precipitating agent, and claim to have been able to measure the 'refractive index' of such waves in passing across a boundary separating regions of different concentration of the gelatine.

The distinguishing character of a true wave is the existence of phase relationships, and connected therewith, the possibility of interference effects. In the course of some studies made by us, we have observed some phenomena with Liesegang precipitates which are unmistakably in the nature of interference effects. To make the significance of our results clear, it is necessary to make here a remark regarding the structure of an interference field. When two wave trains crossing at an angle are superposed, we have, of course, regions of maximum and minimum disturbance. If the minimum disturbance is actually zero along a given line, the wave fronts on either side of it show a difference of phase of half a wave. This is an exceedingly characteristic interference effect and can easily be recognized in ripple photographs.

When on a gelatine film containing a very small concentration of sodium chloride a drop of silver nitrate is placed, the Liesegang pattern consisting of thousands of closely spaced rings of silver chloride precipitate may be observed. On an examination of the precipitate, it is often seen that the patterns are not of uniform intensity everywhere, but show lines of minimum and maximum disturbance, and the effects observed are closely analogous in some cases to beats, and in other cases to interferences of the

INTERFERENCE PHENOMENON OF SILVER CHROMATE RINGS IN GELATIN.

individual waves. In the latter case, the difference of phase of half a wave-length on either side of a line of zero disturbance is invariably to be observed.

Even more striking are the interferences which we have observed in suitable circumstances with silver chromate rings in gelatine. In this case, the pattern really consists of a great number of fine rings, the intensity of which varies in such manner that they form a succession of widely spaced groups. Not only the individual waves, but also the groups, show interference phenomena with the characteristic discontinuity of phase of the group on either side of a line of zero disturbance. The accompanying photograph shows this in a striking way.

C. V. RAMAN.
K. SUBBARAMIAH.

Department of Physics,
Indian Institute of Science,
Bangalore.
July 13.

[1] Nikiforov and Kharmonenko, *Acta Physicochemica U.R.S.S.*, **8**, 95 (1938).

Some New Anthocyanin Types

A WIDE survey of anthocyanins occurring in the angiosperms (and a few gymnosperms) has revealed the overwhelming predominance of pigments based on pelargonidin, cyanidin and delphinidin and methyl ethers of the last two. The only exceptional cases are the nitrogenous anthocyanins, typified by the beet colouring matter, gesnerin from flowers of *Gesnera fulgens*, which is the sole representative of the flavylium class related to flavones rather than to flavonols, and certain yellow pigments such as those of *Papaver nudicaule* and *Celosia cristata aurea*.

The colouring matter of the yellow Iceland poppy has been isolated; it is nitrogenous, and will be described elsewhere. That of the yellow *Cristata* resembles it in some respects, but differs in others; it is doubtful whether either is a flavylium salt.

We have recently found that the red colour of certain *young* fern fronds (the coloration soon disappears) is due to entirely new anthocyanins in some cases; in others the familiar pigments have been identified.

Among the Pteridophyta examined we may mention *Davallia divaricata* as containing mixed pelargonidin and cyanidin dimonosides in an acylated form. This shows that normal anthocyanins may occur in the cryptogams.

The new types occur in *Osmunda regalis* var. *Hillii*, and *O. palustris*, *Didymochloena truncatula*, *Pteris aspericaulis*, *Blechnum brasiliense*, *Dryopteris varia*, *Adiantum Vietchianum* and *Polypodium rhodoleuron*.

The anthocyanins include monoglycosides and diglycosides; the anthocyanidins, of which at least three kinds have been recognized, are not identical with any known polyhydroxyflavylium salts. They resemble, however, 6-hydroxypelargonidin and 6-hydroxycyanidin.

J. R. PRICE.
VIOLET C. STURGESS.

John Innes Horticultural Institution,
Merton Park, London, S.W.19.

R. ROBINSON.
GERTRUDE M. ROBINSON.

Dyson Perrins Laboratory,
Oxford.
Aug. 2.

By-products in Aromatic Nitration

IT was known fifty years ago that hydroxy by-products arise in small quantities in the nitration of benzene and toluene, and their significance was discussed by Armstrong and Rossiter in 1891. Since that time little has been added to the subject apart from a number of observations of the increased production of such by-products in the presence of mercuric salts.

We have now found that, in the nitration of aromatic compounds with *meta*-directive groups, hydroxy by-products are formed in considerable quantity: in the nitration of nitrobenzene, for example, styphnic acid is produced in amounts varying from 0·5 to 6·5 per cent according to the conditions.

The process appears to involve the direct introduction of a hydroxyl group in the *meta* position, followed by complete tri-nitration (directed by the hydroxyl group). The resulting substance then either appears as such—for example, hexanitro-3:3'-dihydroxybenzophenone formed in the nitration of benzophenone; or the original directive group, now subject to the influence of three nitro-groups, is displaced by hydroxyl, and styphnic acid is isolated—as for example in nitrating nitrobenzene, phenyl methyl sulphone or diphenyl sulphone.

G. M. BENNETT.
P. V. YOULE.

The University,
Sheffield.

Quantitative Measurement of Vitamin B_1 and its Phosphoric Esters and their Synthesis in Animal Tissues

RECENTLY, in NATURE, Westenbrink and Goudsmit[1] described estimations of the vitamin B_1 and cocarboxylase content of animal tissues, based upon the observation that thiochrome phospho-esters do not pass into a butyl alcohol layer[2].

In results described to the Biochemical Society on May 5, 1938[3], and embodied in a paper just sent to press, we have given estimations of these two forms of vitamin B_1 by different methods in rat and pigeon tissues. Our methods of estimation are based upon the use of yeast enzymes, and are in some sense complementary to those of the above authors, because the cocarboxylase as estimated by us can only be the diphospho-ester, whereas in their method it is possible that the mono-ester is also included; on the other hand, our method does not distinguish between vitamin B_1 and its *mono*phospho-ester. It is interesting that our main conclusion was substantially the same, that there is more cocarboxylase than vitamin B_1 in most tissues, though muscle in our experiments contains relatively more of the latter. We also found that vitamin B_1 injected into the avitaminous animals is rapidly taken up by the liver, giving an accumulation of both forms of the vitamin; differing from them, however, slightly increased amounts of free aneurin were found in brain and muscle soon after injection. It will be interesting if the points of difference are due to the presence of the monophospho-ester.

We may add that (as already mentioned to the Biochemical Society) liver slices produce cocarboxylase from vitamin B_1. Liver slices or 'brei' may convert 25–30 per cent of the vitamin into cocarboxylase in 30 minutes at 38°. The synthetic reaction has a markedly alkaline *p*H optimum (about 8·5); it is inhibited by iodoacetic acid (0·0009 mol.) and little affected by fluoride (0·04 mol.) or by addition of phosphoglyceric acid and adenylpyrophosphate, whether separately or together. Other tissues show either a very limited activity (brain, muscle) or none at all (intestinal mucosa); kidney tissue has not so far been investigated by us. We have recently found that the synthetic reaction can also be obtained with liver extracts; this is being further investigated.

S. OCHOA.
R. A. PETERS.

Department of Biochemistry,
Oxford.
July 23.

[1] Westenbrink, H. G. K., and Goudsmit, J., NATURE, **142**, 151 (1938).
[2] Kinnersley, H. W., and Peters, R. A., *J. Soc. Chem. Ind.*, **56**, 447 (1937).
[3] Ochoa, S., and Peters, R. A., *J. Soc. Chem. Ind.*, **57**, 470 (1938). See also, Ochoa, S., NATURE, **142**, 831 (1938).

Season and Rate of Conception

THE many difficulties of studying the effect of season upon birth-rate (or conception-rate) have been listed in Huntington's recent book "Season of Birth". Factors such as birth control, a popular season for marriages, the return of males at holiday seasons, etc., all tend to obscure the actual relationship. Because conception—but not the number of young resulting from it—can be influenced in these ways, it seemed wise to find the seasonal effect by studying the ratio of multiple-conceptions to single-conceptions. (It is assumed that the seasonal factors affecting single-conceptions act in the same way, though to a greater extent, in affecting multiple-conceptions.) Suitable data are difficult to find; the best I have been able to obtain are those from medical officers of health in the large cities, and the accompanying table summarizes those very kindly extracted for me by the Medical Officer of Health for Liverpool. They cover the two years 1935–1937. (To medical officers of health, births must be notified within thirty-six hours; the Registrar-General's figures are not so reliable, as births may be notified up to forty-two days.)

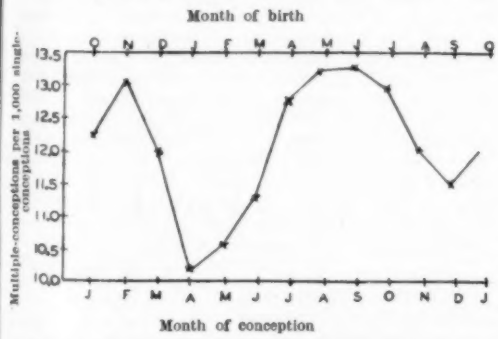
THE NUMBER OF MULTIPLE-CONCEPTIONS PER 1,000 SINGLE-CONCEPTIONS AT DIFFERENT SEASONS OF THE YEAR

Month of conception	No. of single-conceptions*	No. of multiple-conceptions*	Multiple-conceptions per 1,000 single-conceptions	Month of birth
Jan.	2915·25	35·50	12·18	Oct.
Feb.	2753·00	36·00	13·08	Nov.
Mar.	2812·75	33·75	12·00	Dec.
April	2965·00	30·25	10·20	Jan.
May	3057·75	32·25	10·55	Feb.
June	3128·50	35·25	11·27	Mar.
July	3035·25	38·75	12·77	April
Aug.	3116·00	41·25	13·24	May
Sept.	3088·50	41·00	13·27	June
Oct.	3012·50	39·00	12·95	July
Nov.	2978·75	35·75	12·00	Aug.
Dec.	3024·50	34·75	11·49	Sept.

* Standardized to month of 31 days and smoothed by formula $\frac{a+2b+c}{4}$

The numbers of single-conceptions by month of the year do show a seasonal trend but are subject to the influences mentioned above.

The ratio of multiple-conceptions to single-conceptions (1 pair of twins or triplets = 1 multiple-conception) shows two distinct peaks, as illustrated by the accompanying graph, one around mid-February



and another around the middle of August to September. It is suggested that this curve shows the seasonal effect uninfluenced by artificial control and that the increasing hours of daylight to the first peak and decreasing hours to the second offer the best explanation of the phenomenon. An increase in temperature and improvement in environmental conditions (summer holidays, etc.) could not explain the rise in January and February, although they might explain the more extended effect in the second peak. Conversely, the cumulative effects of a debilitating winter environment finally overcoming the light effect at the beginning of the year might explain the low level in April.

It is hoped to study the question further with more data in Great Britain and with data from other countries in different latitudes.

JOSEPH EDWARDS.

School of Agriculture,
Cambridge.
July 19.

Development of the Inert Regions of the Salivary Gland Chromosomes of *Drosophila*

THE present communication is closely connected with my letter entitled "Development of the Giant Salivary Gland Nuclei of Drosophila"[1].

To the genetic conception of inert and active regions of the chromosomes corresponds the morphological conception of the heterochromatin and euchromatin[2]. The heterochromatin regions are situated in the metaphase chromosomes near the spindle fibre attachment point, that is, on the proximal ends of the rod-like chromosomes and on both sides of the spindle-attachment constriction in double-armed chromosomes.

The heterochromatin regions come closely into contact in the telophase, and according to Heitz[3] they fuse and form the chromocentre of the resting nuclei (Fig. 1*a*). The study of the development of the salivary gland nuclei of *D. funebris* has shown an opposite process, namely, the chromocentre is transformed into the heterochromatin region of the *X*-chromosome.

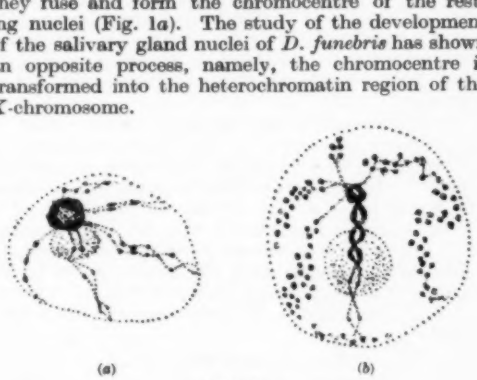


Fig. 1.
(*a*) NUCLEUS OF FAT-BODY CELL OF AN IMAGO OF *D. funebris*. (*b*) SALIVARY GLAND NUCLEUS OF A LARVA OF *D. funebris* ABOUT 2·5 MM. LONG. (×3,200).

The dimensions of the chromocentre of the resting nuclei depend on the total quantity of heterochromatin of all the chromosomes. In *D. funebris* the chromocentre is very large (Fig. 1*a*) and is often divided into parts. In the salivary gland nuclei of small larvæ (2·5 mm. long) the chromocentre lengthens and divides lengthwise into chromomeres arranged in two rows. On the chromocentre, however, two chromosomes twisted together with symmetrically arranged chromomeres are clearly seen in Fig. 1*b*. The distal end of this changed chromocentre passes over into the euchromatin region of the *X*-chromosome. The heterochromatin and euchromatin regions

differ profoundly according to the intensity of Feulgen's reaction. The proximal ends of the autosomes continue to unite with the heterochromatin region of the *X*-chromosome in the same way as they united formerly with the chromocentre.

When the chromosome bands begin to form, the heterochromatin region extends still more and the small number of chromomeres of early stages disintegrate lengthwise into a greater number. When the genonemata become double, the number of chromomeres in the row is also doubled in both euchromatin and heterochromatin chromosome regions. Thus a typical picture of the inert region of the *X*-chromosome of *D. funebris* in the salivary gland nuclei of large larvæ is obtained.

When the bands in the salivary gland chromosomes of *D. melanogaster* are formed, the round chromocentre of a resting nucleus divides into parts belonging to separate chromosomes. These chromosome parts divide into chromomeres later on.

In *D. repleta* the double-armed *X*-chromosome is represented only by one banded chromosome in the salivary gland nuclei. This can be explained only by the fact that the second inert arm forms the chromocentre, which in the large salivary gland nuclei does not differ externally from the chromocentre of the resting nuclei. In other words, this arm retains the same compact condition as in the resting nucleus.

In the large salivary gland nuclei of *D. virilis* and *D. robusta*, the chromocentre of a resting nucleus is retained as in *D. repleta*, but is decreased in dimensions. This can be explained by the fact that in young larvæ small parts separate from the chromocentre and disintegrate into chromomeres. Later on, the number of chromomeres doubles exactly in the same way as in the euchromatin chromosome regions. The remaining part of the chromocentre represents a fusion of small parts of heterochromatin, proximal ends of all the chromosomes in *D. robusta* and in *D. virilis* all the heterochromatin of chromosome III in addition.

The differences of the structure of the point of union of the proximal ends of all the chromosomes in the salivary gland nuclei of large larvæ of different species of *Drosophila* can thus be explained, whether the whole or a section of the chromocentre of a resting nuclei is transformed into the inert chromosome regions, that is, obtains a chromomere structure.

The thread leading from the chromocentre to the nucleus is formed during the transition from telophase to the resting nucleus. Its nature has so far not been made clear.

S. FROLOVA.

Institute of Experimental Biology,
Moscow. June 17.

[1] Frolova, NATURE, **141**, 1015 (1938).
[2] Neitz, *Biol. Zol.*, **54**, 11/12 (1934).
[3] Heitz, *Z. Zellf. u. micr. Anat.*, **19** (1933).

Chromosome Numbers in *Cimex*

A SUB-SPECIES of *Cimex*, phenotypically intermediate between *C. lectularius* and *C. columbarius* and obtained from laboratory white rats, has been found to comprise two forms differing in the number of chromosomes. In most cases the haploid number of autosomes is twenty-four, but in occasional specimens it is sixteen. No variation in phenotype, correlated with this change in number, has been observed, nor is the normal course of meiosis affected.

This suggests that eight autosomes in this subspecies either represent a duplicate set the functions of which can be performed by the remainder of the complement, or are genetically inert.

All *C. lectularius* material so far examined has yielded a haploid autosome count of twenty. Since these three karyotypes form a series having chromosome numbers which are multiples of four, there is reason to suppose that (*a*) the genus is polyploid in origin, (*b*) the stem number in *Cimex* is four and not six as was suggested by Slack[1] and Vandel[2] for the Heteroptera.

H. D. SLACK.

University,
Glasgow.
June 28.

[1] Slack, H. D., British Association, Nottingham (1937) (unpublished).
[2] Vandel, A., *Proc. Zool. Soc.*, A, **107**, 519 (1937).

Time Sequence of Crossing-Over

MATHER[1] has answered the challenge of Charles[2] regarding the time sequence of crossing-over. Like Charles, I feel sceptical of Mather's evidence[3] that crossing-over begins near the centromere.

Mather suggests that the experiments on the effect of age, temperature and inversions in *Drosophila* show the differential effect between the centromere and the ends of the chromosome to be expected on his hypothesis. Before he can use this evidence as a support for his hypothesis, he must first show that the genetically unsplit region near the centromere behaves similarly to the ends of the chromosomes in all other respects than crossing-over. It is perfectly reasonable to suppose that the genetically unsplit region and its neighbourhood react quite differently to external influences. Indeed there is much evidence for this, but it is not necessary to assume, as Mather does, that the observed changes in linkage are due to the fact that the first formed chiasma is proximal to the centromere. If, for example, an increase in temperature influences the distance at which the chromosome is genetically split at the time of crossing-over, the changes in linkage values will be observed no matter where crossing-over started on the chromosome.

The precocious splitting in unpaired parts of trivalent or univalent chromosomes provides more factual evidence than that adduced by Mather. The papers by Charles, Schweitzer and Mather are most useful in suggesting novel modes of attack; but indicate the dangers of jumping to conclusions, however reasonable, which are derived from the cytological or statistical methods at present favoured by many.

Until the mechanics of chromosome pairing are understood, it is difficult to utilize the data of pairing in structurally changed forms in the way Mather has done. A juxtaposition of the centromeres at early meiotic prophase as seen in salivary glands would account for the behaviour of the heterozygote of the Delta 49 inversion, but without factual evidence such a suggestion is as useless as Mather's. It is possible that Mather is correct in his assumption regarding this theory, but more genetical evidence is required before acceptance is possible.

F. W. SANSOME.

Botanical Department,
University of Manchester,
Manchester, 13.
July 25.

[1] Mather, K., NATURE, **142**, 157–158 (1938).
[2] Charles, D. R., *J. Genet.*, **36**, 103–26 (1938).
[3] Mather, K., *J. Genet.*, **33**, 207–35 (1936).

'Bridlington Crag' Shells

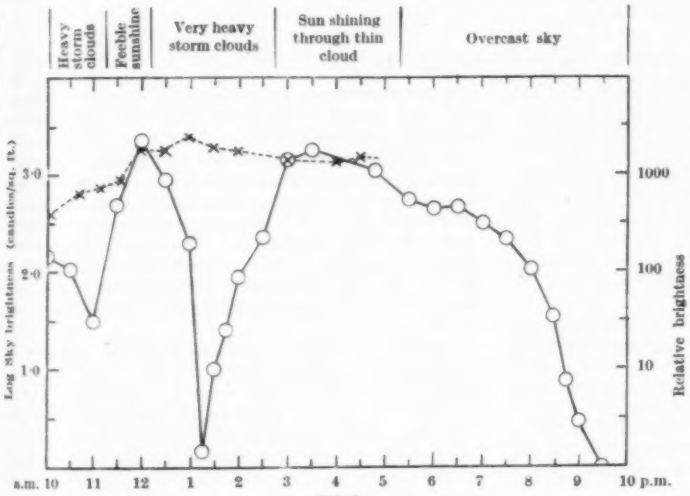
MANY years ago, Mr. W. Headley, a relative of the late G. W. Lamplugh, had an extensive collection of shells from the so-called 'Bridlington Crag' exposed during excavations near the shore at Bridlington. This contained a number of 'types' which had been referred to in the *Quarterly Journal of the Geological Society of London*, vol. 47, 1891. We have been endeavouring to trace these, but have recently ascertained that, before he died, Mr. Headley sold some of his collections, and possibly these were among them. Inquiry has been made as to their whereabouts in the most likely channels, but without result. Is it possible any readers of NATURE can help us, as it is desirable to know where they can be consulted?

T. SHEPPARD.

Municipal Museums, Hull.

Sky Darkening Associated with a Severe Thunderstorm

IT may be of interest to record some observations made here of the abnormal degree of sky darkening associated with a very severe thunderstorm which affected a large area of south-west England during the morning and early afternoon of Thursday, August 4, 1938.



—o—o—, August 4; —x— —x—, August 5.

Observations of the brightness of the sky in the zenith were made by me at frequent intervals during the day with a Weston photo-electric (barrier layer) photometer calibrated directly in brightness units, namely, candles per sq. foot. A neutral (silver deposit) screen of known transmission factor, used in conjunction with the photometer, enabled measures to be obtained of brightness values which lay outside the scale range of the instrument. The photometer was exposed in a horizontal position, the sky radiation received being restricted to a cone of solid angle 60°. The complete series of observations is shown graphically in the accompanying figure, the logarithm of the photometer reading being plotted in order to form a convenient ordinate scale. A scale of relative brightness has been added to facilitate interpretation of the graph. The comparison (broken) curve is that for the following day, August 5, when no precipitation took place during the period of observation, and the sky was continuously overcast. Notes of sky conditions along the upper margin of the figure refer to the day of the storm.

It will be seen that, during the period of most intense storm activity, a wide and rapid fluctuation of sky illumination occurred. Within a period of one hour, from 12.15 p.m. to 1.15 p.m. B.S.T., the brightness value had fallen from 1500 to 1·5 candles/sq. ft. It would appear that the latter value, the absolute minimum recorded, is an unusual one seldom associated with storm centres developing in these latitudes. The abnormally low brightness of the sky is here indicative of a great vertical extent of the cumulo-nimbus cloud layer passing over the observer.

An equally striking return of skylight ensued as the storm centre moved away in a north-west direction. Half an hour after the minimum brightness had been recorded, a reading of the photometer indicated a ten-fold increase in the illumination, and by 2.30 p.m. B.S.T. the reading had risen to 225 candles/sq. ft., the storm clouds being then in process of dispersion. Thereafter, with a 'broken' sky veiled in alto-cumulus and cirro-stratus cloud through which the sun shone feebly, the sky brightness approached a more normal level, a value of 1770 candles/sq. ft. being recorded at 3.30 p.m. B.S.T. By reference to the figure it will be seen that at 9.15 p.m. B.S.T. the normal twilight illumination had fallen to the same value of sky brightness as that observed soon after midday, when the most severe phase of the thunderstorm was being experienced.

D. R. BARBER.

Norman Lockyer Observatory, Salcombe Hill, Sidmouth, Aug. 6.

Dillenian Correspondence

IN the notice in NATURE of July 2, p. 18, of the recent acquisition by the Department of Botany, British Museum, of a large number of drawings by Dillenius and some manuscript, a 'feeler' was put out about the possibility of Dillenius's correspondence similarly coming to light.

A day or two later, having occasion to consult Dawson Turner's correspondence of Richard Richardson (1835)—a book much less well known than it deserves to be as it contains much information about eighteenth-century botanists—I happened across a footnote in the preface (p. ix): since, so far as my inquiries go, this seems to have been overlooked by botanists, it seems worth reprinting.

"As, in speaking of the correspondence of Sloane and Sherard, I have mentioned the advantage derived to science from the preservation of such letters, so is it right here to notice an unfortunate event of an opposite tendency, whereby it is impossible to say how much we may have lost. The event I

allude to is the destruction of Dr. Sibthorpe's papers, and, I fear, with them, of all those of the older Botanists belonging to the Oxford Garden. This, I the rather notice, not only inasmuch as my so doing may serve as a warning, and because the papers in question were in a measure connected with the present volume, but as affording an opportunity of clearing the late Dr. Williams from blame in the transaction. Mr. Upcott had mentioned to me, that he had found upon a druggist's counter at Oxford, sundry letters written by Sibthorpe, Dillenius, &c. and that the druggist had told him they were a portion of a large quantity he had bought from the Botanic Garden; so large that, after keeping what he wanted for himself, sufficient remained to be worth sending to a neighbouring paper-mill. Dr. Daubeny, the present Professor of Botany, to whom I mentioned the circumstance, was kind enough to investigate it, and to write to me as follows: 'The fact is, that, on the pulling down by the street-commissioners of the house belonging to the Professor of Botany, various papers, for which there could not have been room in the only apartments that then remained attached to the garden (the present lecture-room,) were removed to Dr. Sibthorpe's private dwelling-house, which, on the death of the son, and afterwards of the father, fell into the hands of Lady Sewell, daughter of the latter, and sister of the author of the *Flora Græca*. On the decease of that lady some years back, the effects were sold, and amongst them was the lump of old papers you mentioned. With regard to the share which my predecessor, Dr. Williams, had in the transaction, all the information I have been able to obtain, leads me to conclude that, at the time of the sale, he was not aware of such papers being put up to auction. On the contrary, I have been told that, he had several times made application to the Sibthorpe family for the restitution of the books or papers belonging to the garden in their possession; but that they never attended to his request; and that at the sale he actually purchased and restored to the garden several volumes that he had reason to consider as public property.' "

J. RAMSBOTTOM.
British Museum (Natural History),
London, S.W.7.
July 25.

Points from Foregoing Letters

OBSERVATIONS are recorded by Prof. Laby and his colleagues which lead them to conclude that *all* atmospherics are reflected at the ionosphere and lightning is an oscillatory discharge. (In a previous letter to NATURE evidence was given that *some* atmospherics are so reflected.) In principle, this means it is possible to infer from one oscillogram of an atmospheric the height of the ionosphere, and the distance of the lightning from which the atmospheric was radiated. The latter is of considerable practical importance to meteorology and aviation.

A logarithmic time scale was suggested by de Sitter in 1933, and Milne has used two time scales connected by a logarithmic expression. Prof. H. S. Allen points out the similarity between this expression and Boltzmann's formula connecting entropy and probability. Atomic time may be interpreted as a probability, and consequently time as measured by an astronomer or physicist may be regarded as a statistical quantity.

Further numerical relations between fundamental atomic constants and the universal gravitation constant, which coincide roughly with values ascribed to the number of particles in, and radii of, the galaxy and the universe are pointed out by Dr. D. S. Kothari.

Sir C. V. Raman and K. Subbaramiah submit photographs of Liesegang rings of silver chromate, showing an interference pattern with characteristic difference of phase of half a wave-length on either side of a line of zero disturbance.

A chemical investigation of a nitrogenous anthocyanin pigment obtained from the yellow Iceland poppy, and of other new anthocyanin pigments from certain young fern fronds and other plants, is announced by J. R. Price, V. C. Sturgess, Prof. R. Robinson and G. M. Robinson.

Prof. G. M. Bennett and Dr. P. V. Youle find that in the nitration of nitrobenzene and other aromatic compounds with a meta-directive group, hydroxy acids (for example, styphnic acid) are produced in appreciable quantities.

Dr. S. Ochoa and Prof. R. A. Peters have determined by an enzymic method the cocarboxylase and vitamin B_1 (or monophosphate) content of animal tissues and obtained independently similar results to those of Westenbrink and Goudsmit, except for muscle and brain; it is suggested that the differences may lie in the methods. Liver (both slices and extracts) synthesizes cocarboxylase from vitamin B_1 *in vitro*.

A graph showing the ratio of multiple conceptions (twins and triplets) per 1,000 of single conceptions at different seasons of the year is submitted by J. Edwards. It shows a peak around mid-February and another around the middle of August to September.

Diagrams of cell nuclei from the fruit fly, *Drosophila funebris*, showing the distal end of the chromocentre passing over into the 'euchromatin' region of the *X*-chromosome, are submitted by S. Frolova to illustrate the development of inert regions in the chromosome.

From the consideration of autosomes, as distinct from sex chromosomes, Dr. H. D. Slack finds difference in chromosome numbers in *Cimex*, which suggests that polyploidy has played a part in the evolution of the present karyotypes.

Dr. F. W. Sansome considers that more genetical evidence is needed before Mather's view that crossing-over begins near the centromere can be accepted.

Observations by D. R. Barber made with a photo-electric photometer of the brightness of the zenith sky throughout the progress of the storm over south-west England on August 4 indicate that, during the most severe phase, the sky light was reduced to less than one thousandth part of that normally received from an overcast sky at summer noon.

Research Items

Christmas and New Year Among Serbian Gypsies

DR. ALEXANDER PETROVIC concludes his study of feast days among Serbian gypsies with an account of Christmas, New Year and Easter observances (*J. Gypsy Lore Soc.*, **17**, Ser. 3; 1938). Gypsies have many Christmas customs borrowed from the Serbs. These are rites to secure them a favourable year as regards stealing; while on New Year's Day the most important rites are connected with money—the world at large must be informed how much money each gypsy family possesses. If they have money on that day, they will assuredly have it throughout the year. Among the Serbs, Christmas as a holy day occupies a special place. It is a time of joy and merriment, and, as it were, the beginning of a new life. There must be no quarrels, and all kinds of work must be begun to bring good luck. On Christmas Eve, straw is brought into the house and corn is threshed symbolically. The head of the house stands in the centre with a whip and slashes at the women, who represent horses, as they run round him in a circle. Among the gypsies of Kragujevac straw is purchased in conformity with the Serbian custom that straw must be brought into the house; but a few straws must be stolen to accord with gypsy custom. The women go from house to house among the peasants on Christmas Eve and try to steal something from each for their bags, so that their bags may be full throughout the year. At Kopljari, though the peasants observe no special rites on New Year's Eve, the gypsies repeat nearly all the Serbian customs of Christmas Eve. Branches of the Christmas log are used to stir the fire and branches of cornel are brought into the house for the sake of the health of everybody. These used to be decorated with coins, but now banknotes are used, while on New Year's morning all the money in the house is thrown into a blanket spread in the middle of the floor after being poured over branches of the Christmas log. These branches are thrown into a rapid stream to induce money to flow into the house. Among 'Turkish' and Mohammedan gypsies the ceremonial dismemberment and disposal of a turkey play a great part.

Typhoid-Paratyphoid Vaccination in the British Army

LIEUT.-COLONEL J. S. K. BOYD read a paper at the recent meeting of the British Medical Association on recent advances in the preparation of prophylactic typhoid-paratyphoid vaccines in the British Army (*Brit. Med. J.*, August 6, p. 307). The original vaccine used in the Army was prepared from a strain of the typhoid bacillus of low virulence. Later, doubts were expressed regarding the suitability of this typhoid strain for vaccine preparation, and several researches suggested that the degree of protection afforded by a typhoid vaccine corresponded directly with the virulence of the typhoid strain employed. It was also shown that the reaction caused by vaccines of virulent strains was no more severe than that given by the old strain. A mixed vaccine of *Bact. typhosum*, and *Bact. paratyphosum*, *A* and *B*, of proved and tested virulence, was, therefore, brought into general use in the Army in 1933. The results of this measure can best be studied by following the incidence of typhoid fever in the British Army in India. The curve of incidence showed an upward trend until 1919. The vaccine used was then changed to embody 50 per cent of a 'smooth' variant of considerable virulence. From 1929, a decline in incidence occurred, which was sharply accentuated in 1934 following the introduction of the new vaccine. There was no corresponding decline in the incidence of other intestinal diseases, which seemed to show that the improvement in the enteric figures could not be solely attributed to an improvement in general sanitation.

Abnormalities in the Blood of Cancer Patients

IN the *Spisy Lékarské Fakulty Masarykovy University* (Publications of the Medical Faculty of the Masaryk University of Brno (**16**, 97–306; 1937), Dr. L. Havlásek gives an important and lengthy account (with many tables, graphs and 318 bibliographical references) of blood changes in cancerous women. His conclusions are based upon prolonged observations and series of tests made with 57 patients in varying stages of uterine cancer and who were undergoing treatment with radium, X-rays or by administration of certain salts (thiosulphates). The investigation included the determination of the hydrogen ion concentration of blood and urine using the quinhydrone electrode, carbon dioxide determinations and estimations of bicarbonate and hæmoglobin. In addition, the red and the white blood corpuscles were counted and the arterial blood pressure calculated. From these determinations, made over a long period before, during and after treatment, it was observed that though the results were not uniform, there is a definite trend towards the normal figures as the patient approaches recovery.

Flora of Certain Moravian Lakes

THE ecology of certain lakes and ponds near Třebíč and Studenec, in south Moravia, is the subject of a recent paper by Dr. F. Nováček (*Proc. Moravian Sci. Soc.*, **10**, 1–70). The lakes, which have existed for centuries, lie in the valleys of the Rivers Jihlavka and Oslava, which flow into the Morava and thence into the Danube. The district is studded with pine forests, but with very large clearings. The waters have a sandy bottom, more or less covered with mud and sometimes with humus. More than a hundred species of higher aquatic plants are described and the flora shows a marked zonation with littoral, sedge, rush, loosely attached and floating associations. The condition, composition and extent of the zones is influenced by weather conditions, being markedly different in wet or dry summers. Among the plants in the floating associations, the Lemnaceæ predominate, with *Ricciocarpus* near the banks. *Zygnema* and *Mougeotia* types flourish in June and July whilst *Spirogyra* and often *Cladophora* are abundant in spring and autumn. The plants of the other zones are those usually present in stagnant fresh water, for example, species of *Phragmites*, *Typha*, *Glyceria*, *Alisma*, etc., near the water's edge and *Sagittaria*, *Potamogeton* and *Elodea* towards the deeper parts of the lakes.

Crossing-Over in Chromosomes

Important ramifications of crossing-over have recently been reviewed by K. Mather (*Biol. Rev.*, **13**, 182–293; 1938). The genetical evidence from euploids and aneuploids, structural hybrids and diploids, together with the cytological work of recent years, establishes the conditions of chiasma formation on a firm basis. The inter-relationships of chromosome pairing, chiasma formation, disjunction and segregation and crossing-over are discussed, and it is shown that precise estimation can be made of segregation, linkage and the gametic output of structural hybrids and polyploids. The author also explains his previously published theories, in which he claims that the first chiasma formed is proximal to the centromere, and that there is a localization of the position of the proximal chiasma on the chromosome.

Mycology of the Philippines

THE first two numbers of vol. 65 of the *Philippine Journal of Science* are devoted to a compendious paper on "Philippine Mushrooms" by José Miguel Mendoza (128 pp. + 79 plates, January–February 1938). The account is written upon a scientific basis, but is designed to instruct the Philippine population in edible and poisonous species. This it does to the extent of outlining culinary uses of various kinds, describing methods for cultivating *Volvaria esculenta*, and indicating the antidotes to fungal poisons. Mycological descriptions are given with sufficient macroscopic detail to allow comparison with other regions, while the plates provide further artistic delineation of many species. A strong European element is noticeable in the flora as here portrayed, but as the text is not critical, any purely Philippine element may not as yet be sufficiently evident.

Seismological Research in Japan

USING Miss E. F. Bellamy's "Index Catalogue of Epicentres for 1913 to 1930" as data, Seiti Yamaguti has discussed anew the "Seasonal Distributions of Earthquakes in the World" (*Bull. Earthquake Res. Inst.*, Tokyo Imperial University, **16**, Part 2; June, 1938.) It is found that, on the average, the season number with maximum frequency seems to increase from western to eastern longitudes and from northern to southern latitudes, with the second season (June–August) as the mean. When the earthquake frequencies are plotted against the months, it is notable that the curves for Japan and the Mediterranean coast are opposite in phase. The Fourier coefficients for the annual distribution, the relative amplitude of the annual term, and the phase of maximum have all been evaluated and compared with what may be expected as the result of fortuitous happenings. It is found that the times of maximum frequency change in the northern hemisphere from June to November successively, according to latitudes, a succession that is too regular to be attributed to chance. In the same bulletin, Prof. K. Sezawa discusses the "Anomalous Dispersion of Elastic Waves", notably Love waves and Rayleigh waves in certain defined conditions. Altogether there are eighteen papers ranging from pure geology to mathematical seismology; thirteen of the papers are in English and the remainder in Japanese with summaries in English. Accompanying the *Bulletin* is the "Seismometrical Report of the Earthquake Research Institute, Tokyo Imperial University, 1937, Part 3–4 (July 1–December 31, 1937) which gives a list (in Japanese) of earthquakes sensible in Tokyo for the period stated, and which is adjoined to a map indicating the epicentres of these earthquakes.

Atomic Weights and Isotopes

THE reports of the committees on atomic weights and atoms of the International Union of Chemistry (*J. Chem. Soc.*, 1101, 1110; 1938) propose some changes of atomic weights and report some new isotopes. Among the former the most interesting are (older values in brackets): hydrogen 1·0081 (1·0078), helium 4·003 (4·002), and carbon 12·010 (12·01). Attention is also directed to the atomic weight 207·205 found for lead from a specimen of galena occurring in a vein which cuts one of the pitchblende veins of the Great Bear Lake deposit; this appears to be common lead, and if so it is one of the oldest to be examined. A new rare isotope of tungsten (180) and a very rare isotope of osmium (184) have been discovered. It has proved impossible to detect the isotopes 197 and 203 of mercury.

Research at the Cape Observatory in 1937

H.M. ASTRONOMER at the Cape, Dr. J. Jackson, reports that during the year 1937 the large number of 15,490 transits of stars were obtained with the reversible transit circle. During the daytime, 883 observations were made, including transits of bright stars in the equatorial belt generally between 9 a.m. and 11 a.m. South African Standard Time. With the 8-inch transit circle, the observation of reference stars for the Cape Astrographic Zone, − 35° to − 40°, was completed; the observation of similar stars for the Zone − 52° to − 56° was commenced. The Victoria telescope—a Grubb photographic refractor of 24 inches aperture—continues to be used for the determination of stellar parallax; 3,476 plates were obtained. Since this programme was started in 1926 at the Cape, the parallaxes of 836 stars have been published. Another 18 parallaxes await publication, including the parallax determinations of the very bright stars, Sirius, Canopus and Antares. The result for Canopus, a super-giant star, indicates a considerably larger parallax than that generally adopted. The Victoria telescope has also been used for photographing galactic clusters south of − 30°, the exposures ranging from 5 minutes to 2 hours. In pursuance of a programme of photographic zone observations, according to methods developed by Prof. Schlesinger, the triplet lens of 6 inches aperture is now being employed on Zone − 52° to − 56°. All plates for the Zone − 30° to − 35° have been measured and reduced, 12,500 stars having been measured in both direct and reversed positions on each of two overlapping plates. The time service and wireless time signals have been maintained. Photographs of the sun were taken on 343 days; these negatives are sent to Greenwich for inclusion in the series to be measured for sunspot positions and areas. The mean temperature for the year was 63·4° F. (mean of maxima and minima); the absolute maximum was 98·0° F. on February 17 and the minimum 38·1° F. on May 16. The total rainfall—the highest since 1905—was 28·12 inches, or 4·69 inches above the adopted normal. In concluding his report to the Secretary of the Admiralty, H.M. Astronomer refers to the valuable services of two members of the staff who have retired on pension, Mr. A. Pilling and Mr. T. R. Miller.

The International Congress of Anthropological and Ethnological Sciences

A SESSION of the International Congress of Anthropological and Ethnological Sciences took place in Copenhagen on July 31–August 6, and was followed by a two-day tour through parts of Denmark for members of the Congress who could spare the extra time required. Actually it was only the second time that this most newly fledged of congresses had met, and its great success testifies to the ever-growing interest throughout the world in the study of man, as well as to the immense trouble taken by the Danish organizers to see that everything should proceed smoothly and without any hitch. More than seven hundred members and associates were present, some 29 countries and 177 learned societies and institutions being represented.

The official opening meeting of the Congress did not take place until the afternoon of August 1, but already there had been a reception on the previous evening to enable members to meet one another. This was an excellent arrangement. After all, the main function of these international gatherings is not so much to facilitate the announcement of startling discoveries as to permit specialists from various countries to meet each other and discuss together their ideas and problems, the papers in general being little more than pegs upon which friendly, often almost informal, discussions can be hung. In this respect, the organization at Copenhagen was perfect. On several evenings there were after-dinner receptions in museums, etc., where innumerable discussions took place, helped by a liberal supply of Carlsberg beer and light refreshments!

The official opening ceremony was dignified by the presence of H.M. the King of Denmark, to whom delegates from several countries were presented. Inaugural ceremonies can easily become somewhat tedious functions: not so this one. His Majesty's presence testified to the importance of the occasion and, further, the proceedings were kept commendably short. Besides the necessary speeches of greeting from some of the national delegates and an oration from Dr. Thomas Thomsen, head of the Department of Ethnography in the National Museum and president of the Congress, there was a short orchestral symphony by Kunzen (1761–1817) which helped to lighten the proceedings. Later in the afternoon there was a motor-bus tour of the city.

On Tuesday morning, the work of the sections began and continued daily until the final closure on the Saturday afternoon, with the exception of Thursday, which was devoted to an all-day excursion. There were seven sections, a number of which were subdivided. From A to G they were severally concerned with physical anthropology and allied matters; psychology; demography; ethnology; ethnography, there being sub-sections dealing with Asia, Africa, America, Oceania, the Arctic and Europe; sociology and religion; linguistics and writing. Obviously it is not possible to discuss all the papers here; for that one must await the publication which will appear in due course. But mention can be made of one or two.

"What is a Human Race?" was discussed in Section A by Dr. Nordenstreng of Uppsala, where, too, Dr. F. Weidenreich tabulated a "Classification of Fossil Hominids" definitely placing the existence of *Homo sapiens* in a period anterior to that of our well-known fossil remains of *Homo primigenius*. Questions of blood groups also came up for discussion in this section. In Section D (Ethnology) a paper by Prof. Hatt on the ownership of cultivated land in early times produced an interesting discussion, as also did those by Prof. Herskovitz on the economic surplus and its disposal and by Prof. Firth on the characteristics of a primitive economy. In this section, too, the problems of the development of primitive agriculture and of the horse in Neolithic times were dealt with by Dr. Miles and Dr. Gandert respectively, as well as the first cultivation of wheat and the spread of agriculture, by Mr. Harold Peake.

The sub-sections of Section E provided a wealth of papers. Perhaps one may mention especially those by Profs. Arik and Kansu on recent excavations and palæolithic discoveries in Turkey and by Sir Theodore Tasker on the archæological wealth of the State of Hyderabad, not that there were not many other papers of importance but because these three bore witness to the anthropological work that has recently been so successfully started in these distant regions. Among other British anthropologists present who read papers were Profs. Hutton and Daryll Forde and Dr. Lindgren. Any account of these sectional papers is, however, bound to be invidious at this stage, since the writer was only able to listen to a limited number and to gain information from his friends who had been to others.

A few joint meetings of various sections took place where slides and films were shown. Thus Dr. Morley demonstrated the results of twenty-five years of research in the Maya area of Middle America, while at another time ethnographical films were projected. A general meeting to see films of Greenland, Old and New, was arranged for one evening, and this was preceded by a talk from Mr. Daugaard-Jensen, the chief administrator in the country, who gave us an impressive account of what Denmark has done and is doing for the Greenlanders.

Throughout the period of the Congress, the National and other museums were open free of charge to members. The National Museum has been recently reconstructed and enormously enlarged. Not only are the prehistoric collections from Denmark and the immense series of Eskimo objects unique in the world, but also the arrangement of the Museum is most carefully thought out. It is not a mere storehouse of specimens: to follow the sequence of galleries is an educational experience. If only the British Museum could be rearranged in a like manner! One evening, a reception was held at the Museum and the closing scene was really emotionally memorable. At 10.30 p.m. everyone assembled in the great courtyard, where there are model megalithic monuments in the open air. Then a museum showcase was opened and two great Bronze Age *Lurer* were taken out and handed to two trumpeters who, standing on some steps above the assembled members, proceeded to play stirring duets upon them. The effect was electric—were we not listening to instruments which had first been played more than 3000 years ago?—and it was enhanced by the knowledge that the performance can seldom be repeated, the authorities

being justly fearful lest the vibration might shatter these ancient and beautiful trumpets.

The excursion on Thursday was to Elsinore and the Castle of Frederiksborg. At the former place, in the great hall of Hamlet's Castle, a lecture on "Natural Philosophy and Human Culture" was delivered by the distinguished physicist Prof. Niels Bohr. The municipality of Marienlyst, a seaside resort close to Elsinore, most kindly provided a lunch which was preceded by a display of water acrobatics by Greenlanders in their kyaks: and an astonishing display it was. On the last evening, members dropped their science and became ordinary human beings. After a really sumptuous dinner *chez Nimb* they either danced or passed into the Tivoli (Copenhagen's White City), where the learned were seen happily smashing plates at 5 shies for 6*d*. or careering madly down the scenic railway—of such is a true League of Nations!

In conclusion, unstinted praise must once again be given to the organizing committee, and in this connexion the name of Dr. Birket-Smith must especially be mentioned. He was always helpful and always at hand. Everything worked splendidly, and anyone who has ever had to 'organize' more than 700 people on excursions, at lectures, for entertainments and meals will realize what this means. Nor did the consideration of our Danish hosts confine itself to the full members alone. As always, a number of associates, wives of members and others, were present who might perhaps be expected to be less interested in attending religiously the meetings of the sections, and for these people special activities, including a ladies' lunch at the Yacht Club, were arranged by a ladies' committee. Parties, for example, visited the porcelain works and the not less famous Georg Jensen silver works. There is no doubt that everyone worked very hard to make the Congress the success it was, and certainly their labours were much appreciated. Fortunately, the opportunity occurred to tender the thanks of the guests both formally at the closing meeting and, more informally, a little earlier during an afternoon reception in the Town Hall given by the Municipality of Copenhagen. The Portuguese delegate, when replying to a speech of welcome from the Burgomaster, took full advantage of this opportunity. Finally, in this connexion the name of Prof. J. L. Myers cannot be forgotten. As one of the general secretaries he has had to work hard behind the scenes for many months past to ensure that the gathering should be the very great success it assuredly was. Members and associates will long remember the second meeting of this Congress held in Copenhagen.

M. C. BURKITT.

The International Astronomical Union

THE sixth triennial meeting of the General Assembly of the International Astronomical Union was held at Stockholm on August 3–10 under the presidency of Prof. E. Esclangon. The meeting was the largest and most representative held so far, with more than four hundred people present, including nearly a hundred from the United States. Germany has so far not seen its way to join the Union, but there were more German astronomers present than on any previous occasion. The local organization under Prof. H. von Zeipel, Prof. B. Lindblad and an indefatigable secretary, Dr. Y. Öhman, was extremely good, and combined with perfect weather to contribute to the complete success of the meeting.

After the opening meeting, when the Union was welcomed by the Minister of Justice, the president of the Royal Swedish Academy of Sciences and the chairman of the Swedish National Academy of Sciences, the Union settled down to the task of discussing the reports of the thirty-one committees through which its work is carried out between meetings.

In addition to the specialist discussions carried on in these separate small bodies, there were arranged this time two symposia with a wider range of interest —one on the formation of bright lines in celestial spectra and one on the problem of galactic structure.

Sir Arthur Eddington presided over the first meeting and the speakers were Prof. H. N. Russell, Dr. H. Zanstra, Prof. D. H. Menzel and Dr. P. W. Merrill. At this meeting, M. B. Lyot showed slides of his direct photographs of the corona and the coronal spectrum secured at the Pic du Midi and also a striking cinema film of movements in prominences taken by direct photography. This aroused such enthusiasm that it had to be shown on a second occasion during the meeting. It included one remarkable instance of an existing prominence being blown up by an uprush of fresh matter from below, numerous instances of matter flowing upwards and still more frequently of matter streaming horizontally or downwards in striking arch formations. The second symposium was presided over by Prof. Lindblad, and the speakers were Dr. B. J. Bok, Prof. Lindblad, Prof. H. Shapley and Dr. Becker. Dr. Baade's photographs showed what striking advances in photographic sensitivity had been achieved recently in the red.

Both discussions led to useful contributions from other speakers and they formed a valuable innovation. It was felt in certain quarters that the symposia and the lavish Swedish hospitality had encroached to some extent on the time usually allotted to the work of the committees, but the excursions, especially that on a steamer in the archipelago of Stockholm, gave ample opportunity for another and very valuable side of the activities of the conference—the discussions between small groups of colleagues gathered together from all over the world.

Among the resolutions adopted by the Committees and later by the General Assembly, a few may be mentioned as having a field of interest outside too specialist a range. A list of standard notations was agreed to; arrangements were confirmed for studies on early Egyptian and Russian astronomy and a recommendation adopted that the scientific letters of Sir Isaac Newton should be edited and published. Owing to the failure of the world schemes of longitude determination by radio signals carried out in 1926 and 1933, to show any evidence of longitude variation, it was decided to carry out no further scheme of a similar nature for another ten or twelve years at least. Steps were agreed to for hastening the completion of the catalogue of the *Carte du Ciel*; the

co-ordinates of stars in the *FK3* catalogue were adopted for time determination from January 1, 1940. The Union adopted the specification of the primary standard of wave-lengths formulated in 1935 by the International Committee of Weights and Measures, and adopted fresh secondary iron standards in the ultra-violet and solar standards in the infra-red; it also agreed to a standard notation for describing lines. A special grant was made towards the expense of reproduction of the Utrecht photometric solar atlas giving the profiles of all Fraunhofer lines from Mount Wilson plates between 3300 and 8900 A.

It was agreed to give presidents of commissions wider powers to form sub-commissions with the view especially of developing work in subjects bordering on the special work of two or more commissions, and an additional commission on inter-stellar matters was created.

An invitation to hold the next meeting in 1941 in Switzerland was accepted very cordially and the executive committee for the next three years was elected as follows: *President:* Sir Arthur Eddington (Great Britain); *Vice-Presidents:* Prof. G. Abetti (Italy), Dr. W. S. Adams (U.S.A.), Prof. O. Bergstrand (Sweden), Prof. W. Brunner (Switzerland) and Prof. Ch. Fabry (France); *Secretary:* Prof. J. H. Oort (Holland).

Humidity in the British Isles

THE importance of humidity as a climatological element has been increasingly realized in recent years. Until quite recently, however, comparatively few summarized data were available for the use of industrial technologists, bioclimatologists and others to whom the humidity of the air in the British Isles is a matter of concern. There were, in fact, only two published collections of average values, W. F. Stacey's averages, with charts, for 91 stations in England and Wales[1] and Section 6 of "The Book of Normals"[2] containing hourly averages for five observatories, with isopleth diagrams of hourly averages for seven additional stations.

In both these publications, relative humidity was the only element treated. Stacey's averages were based on readings at 9 h. during the ten years 1901–10, and his stations were sufficiently numerous to give a fair representation of the average distribution of relative humidity over England and Wales at 9 h. It is difficult, however, to draw any useful conclusions from charts and averages based on observations at 9 h., an epoch at which relative humidity is normally in process of descending from the early morning maximum to the afternoon minimum. This limitation will be realized if one imagines how incomplete our information about air temperature would be if we had nothing beyond the readings of an ordinary thermometer at 9 h.

Apart from relative humidity, there are at least two other hygrometric elements for which scarcely any summarized data have hitherto been available, namely, vapour pressure and moisture content. Averages for the principal observatories are given in Bilham's "Climate of the British Isles"[3], but it is clearly desirable that values of these two important elements should be available for a large number of stations.

These needs have now been met by an official publication* recently issued. In view of the fact that the book contains an explanatory introduction, 21 pages of tabular matter and 26 charts, it may be described as extraordinarily good value for money. The main table contains monthly and annual averages for 44 synoptic stations, six columns of data being given for each station. The first four columns refer to 13 h. and contain 15-year averages of air temperature, relative humidity, vapour pressure in millibars, and moisture content in grams per cubic metre. The remaining two columns contain averages of relative humidity at 7 h. and 18 h. In Table II we have hourly averages of relative humidity at nine stations These have in the main been reprinted from previously published averages for first-order observatories, but data from two new stations, Sealand and Cranwell, have been added to improve the geographical distribution. Table III contains hourly averages of vapour pressure at Kew and Eskdalemuir. This is followed by an appendix containing the standard values of the vapour pressure and moisture content in saturated air at all temperatures from 0° F. to 120° F. These are based on the determinations of Scheel and Heuse and are given to two places of decimals[4]. In combination with the data contained in Table I, they afford the means of calculating average values of such quantities as saturation-deficit and dew-point, the methods of doing so being explained in the introduction.

The charts show the distribution of relative humidity and vapour pressure at 13 h. over the British Isles in each month and the whole year. The scale, though small, is sufficient to display the general features of the geographical distribution, and to permit of the possibility of interpolating values for particular places with fair accuracy. The charts show that the distribution of mean relative humidity at midday is, as might be expected, complementary to that of mean maximum temperature, the lowest values being found in the inland areas where the afternoon temperature is high. In addition, there are clear indications of Föhn effects in winter months, patches of relatively dry air being located along the Great Glen, on the east coast of Scotland and along the Welsh border. The dry air during the night hours in the Great Glen results in Fort William having the lowest daily mean humidity of the nine stations for which hourly averages are given. Another interesting fact revealed by the new data is that at Eskdalemuir in the southern uplands of Scotland, the diurnal range of vapour pressure is substantially greater than at Kew in summer months. It is impossible in this article to enter upon any general discussion of the data, but it is clear that this publication contains sufficient information to meet the needs of most inquirers.

* "Averages of Humidity for the British Isles". M.O. 421. (London: H.M. Stationery Office.) 9*d.* net.

[1] Stacey, W. F., "Distribution of Relative Humidity in England and Wales", *Quart. J. Roy. Met. Soc.*, **41**, 45 (1915).

[2] "The Book of Normals". M.O. 236. Sec. VI. "Normals of Relative Humidity". (London: H.M. Stationery Office, 1928.)

[3] Bilham, E. G., "The Climate of the British Isles" (Macmillan and Co., 1938).

[4] Scheel and Heuse, *Ann. Phys.*, 1909 and 1910.

Reclamation of Tidal Lands

IN the *Journal of the Royal Society of Arts* of July 15, 1938, there is published the paper read before a meeting of the Society on February 23 by Mr. Oscar Borer, chief engineer of the River Ouse Catchment Board, in which he gave a survey of the reclamation of tidal lands which has been proceeding on both sides of the North Sea. In a brief note on the geological history of this sea, the author shows that, whether it be accounted for by one theory or another, its water holds in suspension a fine sand or silt which was ground to its present state during the glacial period. This silt only settles in quiet protective bays where the flood water can come to rest; the aim of the work of reclamation is therefore to create those favourable conditions requisite for the extension of the land from the enormous stock of silt provided by Nature. Nature not only provides the material but also constitutes the agency by which the main operations are carried out. Here the engineer exercises his highest function in studying the methods of Nature and in directing them so that they benefit mankind.

If the natural process of accretion be not assisted by artificial means it becomes stationary after reaching a certain distance from the shore, because beyond that distance the movement of the flow and ebb of the tide does not admit of the quiet conditions favourable for deposit. When a sea marsh is enclosed by a bank, the movement of the water is restricted, and, outside the bank, accretion takes place rapidly, so that in a few months the sand becomes covered with warp. This is followed by a growth of samphire, which is, in turn, succeeded by grass, so that eventually the surface consists of a fine mass of warp mixed with roots of grass and decaying vegetable matter. In the course of a few years this process results in the production of a highly fertile soil which, however, must not be enclosed until a sufficient number of years have elapsed and the land thus reclaimed has become 'ripe'—a process taking about twenty years. Meantime, of course, no accretion beyond this is taking place, so that it will be realized that the work is such as to demand patience, foresight and continuity in its direction.

In the course of the lecture, many details were given of the work carried out since Roman times and of the different methods adopted in the operations at the Wash, in the Netherlands and on the German North Sea coast, at each of which the necessary favourable conditions exist. Mr. Borer also mentioned the various plants and grasses which assist the work and the order in which they appear.

Science News a Century Ago

British Association at Newcastle-upon-Tyne

ON taking the chair of Section A (Mathematical and Physical Science) of the British Association, on Monday, August 20, 1838, Sir John Herschel said that the Committee had decided on the order of proceedings for the Section, but it had been found difficult to arrange matters, as although notices of abundance of communications had been received, few papers had come to hand and it was almost impossible to get in touch with contributors owing to a lack of knowledge of their addresses. The part of the proceedings he considered most valuable and important was the opportunity to ask questions. In exercising this privilege members, however, would do well to condense their remarks.

Importance of Meteorological Data

AMONG the contributions to Section A of the B.A. at Newcastle-upon-Tyne was "A Report explaining the Progress towards developing the Laws of Storms" by Lieut.-Colonel W. Reid, R.E. His attention, he said, had been first directed to the subject in 1831 when he was on military service in Barbadoes. A hurricane had occurred just before he arrived in the colony and for two years and a half he had been employed among the buildings which had been ruined. In the course of his paper he referred to the observations of Benjamin Franklin and of Col. Capper of the East India Company, the writings of W. C. Redfield of New York, the anemometers of Whewell and Osler, and he pointed out the desirability of preserving the logs of ships, and of inducing the several maritime nations to establish registers at their lighthouses, and mutually to communicate their observations.

Waves and Water Resistance

To Section A and also to Section G (Mechanical Science), John Scott Russell contributed papers on waves and the resistance of water. He and Sir John Robison, he said, had been constituted a committee to prosecute the investigation of the motion of waves and other problems in hydrodynamics. As to the general problem of the resistance of a fluid to a floating solid, this was a department of science of which we were avowedly ignorant; so much so that some of our best vessels were acknowledged to be constructed by rule of thumb. The question of resistance resolved itself into that of the motion of waves. Waves were of various kinds. The laws of the great primary wave had been laid down in previous communications. Its velocity depended simply on the depth of the fluid. The old law of resistance, as the square of the velocity, was too small so long as the velocity of the solid was less than that of the wave, but too great so soon as the velocity of the solid becomes greater than that of the wave.

Structure of Teeth

THE most important paper before Section E (Medical Science) was that on the structure of teeth and the resemblance of ivory to bone, as illustrated by microscopical examination of the teeth of man, and of various existing and extinct animals, read by Richard Owen, then Hunterian professor and joint conservator of the Hunterian Museum. Until recently, Owen said, the analogy of tooth to bone was supposed to extend no farther than related to the chemical composition of the hardening material, while the arrangement of this earthy constituent, as well as its mode of deposition during the growth of the entire tooth, were considered to be wholly different from those of bone, and to agree with the mode of growth of hair and other so-called extra-vascular parts, with which the teeth undoubtedly closely correspond in the generative properties. Owen referred at length to the work of Prof. Retzius of Sweden, and explained the views he himself held on the analogy subsisting between tooth and bone, illustrating his observations by description of teeth of both living and extinct species. Through the endless diversity which the teeth of different animals present, he said, the general law of the tubular structure could be unequivocably traced.

Societies and Academies

Paris

Academy of Sciences, June 27 (*C.R.*, **206**, 1933–2038).

R. ESNAULT-PELTERIE : The yield of thermal machines.

CHARLES ACHARD, AUGUSTIN BOUTARIC and MME. MADELEINE ROY : Researches on the optical activity of the seric proteins.

MARC KRASNER : A generalization of the local theory of bodies of classes. Generalization of Hasse's symbol and the law of isomorphism for Galoisian extensions. Local analogue of Tschebotarŏw's law of densities.

ZEEV NEHARI : A theorem on functions a mean value of which is limited.

STEFAN BERGMANN : Meromorph functions of two complex variables.

ROGER SERVILLE : The passage from the viscous regime to the hydraulic regime for the translation of a solid in water. The existence of five regimes of flow.

JEAN DUFAY : The structure of the violet cyanogen bands in the spectra of comets.

WILLY BENEDICTUS : Dirac's equations in a space, with Riemannian metrics.

FÉLIX JEAN TABOURY : The application of the properties of polished electrodes to the study of zone of passage, Beilby layer, electrolyte.

RAYMOND CHEVALLIER and MLLE. SUZANNE MATHIEU : The spontaneous evolution of the magnetic properties of ferric hydroxide. By carrying out the magnetic measurement in the tube in which the ferric hydroxide is precipitated, the changes can be followed starting with the third minute after precipitation. The increase in the coefficient of magnetization is more rapid as the medium in which the precipitate is formed is more basic.

MAURICE BILLY and ALAIN BERTON : The absorption spectra by reflection of solid substances in the visible and ultra-violet regions. Value of the method.

PIERRE JACQUINOT : The exactitude of the linear law in the simple cases of Zeeman effects.

JEAN THIBAUD and PAUL COMPARAT : The stimulation of nitrogen nuclei by rapid neutrons passing through paraffin.

MLLE. MARIE LOUISE DELWAULLE : The application of the Raman effect to the identification of a mercuric chlorobromide.

FRANÇOIS BOURION and EMILE ROUYER : The determination of the total hydration of the ions of barium nitrate.

(*To be continued*)

Calcutta

National Institute of Sciences of India

Symposium on 'Weather Prediction' at Poona, July 25–26.

S. R. SAVUR : Seasonal forecasting in India.

S. BASU : Franz Baur's forecasts for 10-day periods.

S. N. SEN : Air mass analysis and short period weather forecasting.

S. K. PRAMANIK : Application of air mass analysis to the problem of the forecasting of nor'westers in Bengal.

K. R. RAMANATHAN : Upper air data and weather forecasts.

N. K. SUR : Latent instability in the atmosphere, and its consequences.

S. P. VENKITESWARAN : Rainfall due to the winter disturbances and the associated upper air temperatures over Agra.

S. K. PRAMANIK : Upper air data and weather forecasts.

P. R. KRISHNA RAO : Weather forecasting for aviation with special reference to local forecasts.

S. K. BANERJI : Kinematical methods in weather forecasting.

Rome

National Academy of the Lincei (*Atti*, **27**, 145–188 ; 1938).

E. MARCUS : Geometrical interpretation of the equation $\frac{\delta^2 \log \beta\gamma}{\delta\mu \ \delta\nu} + \beta\gamma = 0$ and some properties of congruences of straight lines of the canonical assemblage.

G. D. MATTIOLI : Reduction of degree of systems of Pfaff.

C. PAUC : (1) Extension of some properties of surfaces and of V_3^2 varieties to non-holonomous V_n^{n-1} varieties. (2) Images of ordered ensembles. Polygons. Curves.

G. COLONETTI : The second principle of reciprocity and its applications to the calculation of permanent deformations (2).

C. JACOB : Generalization of a formula of Cisotti and its application to the study of slow motions of a compressible fluid.

L. SONA : Some rigid configurations of vortex filaments perpendicular to one plane (2).

T. PERRI : Researches on a cycle of histological modifications of the thyroid of the male albino rat.

Tokyo

Imperial Academy (*Proc.*, **14**, No. 5, May 1938).

AKIRA KOBORI : The multivalence of a group of analytical functions.

YUKIYOSI KAWADA : On Riemann surface algebraical functions.

CHUJI TSUBOI : Gravity anomalies and the corresponding subterranean mass distributions.

TAKESI NAGATA : Magnetic anomalies and the corresponding subterranean structure.

KYOSUKE TSUDA and SEIKICHI KITAGAWA : Dehydration of triterpene alcohols by means of finely divided copper.

TEIICHI KOBAYASHI and MASARU KATAYAMA : Further evidence concerning the chronological determination of so-called Rhæto-Liassic floras, with a description of *Minetrigonia*, a new subgenus of *Trigonia*.

TATURO MATUMOTO : A biostratigraphic study of the Cretaceous deposits of the Naibuti Valley, South Karahuto. The association and the order of occurrence of genera and species in this region are not always parallel to those of the equivalent forms in Europe and other regions. Thus the so-called standard scale of Europe must not be applied directly to the stratigraphy of the North Pacific region.

YOSHIKI MIKAMI : Experiments on the formation of free lenses in *Triturus pyrrhogaster*, with special reference to Harrison's experimental results in *Amblystoma*.

Forthcoming Events

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (CAMBRIDGE MEETING).

Monday, August 22

At 10 a.m.—Dr. H. B. G. Casimir, Dr. J. F. Allen, Prof. J. H. Van Vleck, Dr. F. Simon, Sir J. J. Thomson: "Low-temperature Physics, with special reference to Helium II" (Symposium: Section A).

Prof. W. Cramp, C. E. Webb, D. C. Gall, Dr. L. G. A. Sims and J. Spinks, J. Greig and J. E. Parton and E. V. D. Glazier and J. E. Parton: "Magnetic Measurements with special reference to Incremental Conditions" (Joint Discussion: Sections A and G).

Prof. E. K. Rideal, F.R.S., Prof. W. L. Bragg, F.R.S., Dr. G. Nagelschmidt: "Clays" (Discussion: Section B).

Prof. H. H. Swinnerton: "Development and Evolution" (Presidential Address: Section C).

Dr. J. S. Huxley, F.R.S., Dr. H. B. Cott, D. Lack, I. H. Burkill: "Sense Perception and the Evolution of Colour and Pattern" (Symposium: Section D).

Prof. V. Gordon Childe: "The Orient and Europe" (Presidential Address: Section H).

Dr. A. S. Watt, Dr. H. M. Steven, R. Ross: "The Ecological Aspects of Afforestation" (Joint Discussion: K and K*).

J. Paley Yorke, Dr. W. A. Richardson, F. Pick, Prof. Winifred Cullis: "Education for a Changing Society" (Discussion (continued): Section L).

J. A. McMillan, Prof. F. L. Engledow, C. T. Gimingham, Sir John Russell, F.R.S.: "The Practical Problems of Crop Production" (Discussion: Section M).

At 10.45 a.m.—F. H. W. Green, A. E. Stephens, G. Hayes and Miss M. Chriss, W. G. East, O. Borer: "English Ports and Estuaries in their Geographical Setting" (Section E).

At 11.15 a.m.—Dr. H. von Eckermann, Lieut.-Colonel W. Campbell Smith, S. I. Tomkeieff and Prof. C. E. Tilley, F.R.S.: "The Origin of Carbonate Rocks Associated with Alkali-rich Intrusions" (Discussion: Section C).

At 2.15 p.m.—H. C. Gilson: "Lake Titicaca (Semi-popular Lecture: Section D).

At 3.15 p.m.—Exhibition of Biological Films (Section D).

At 8.30 p.m.—Prof. M. L. E. Oliphant, F.R.S.: "The Contribution of the Electrical Engineer to Modern Physics" (Evening Discourse).

Tuesday, August 23

At 9.45 a.m.—Sir F. Gowland Hopkins, F.R.S., Prof. E. C. Dodds, Prof. L. Ruzicka, Dr. A. S. Parkes, Prof. J. W. Cook, F.R.S., Dr. T. Reichstein, Prof. A. R. Todd: "Repercussions of Synthetic Organic Chemistry on Biology and Medicine" (Discussion: Section B).

At 10 a.m.—Dr. F. J. W. Whipple, J. S. Hughes and Miss E. F. Bellamy, Prof. O. T. Jones, F.R.S., Miss I. Lehmann, Dr. D. W. Phillips, T. F. Gaskill, Dr. H. Jeffreys, F.R.S., Dr. R. Stoneley, F.R.S., Prof. J. D. Bernal, F.R.S.: "Seismology" and presentation of report of the Seismological Committee (Symposium: Section A).

Prof. J. Gray, F.R.S., J. E. Harris and Dr. Lissmann, Dr. F. S. J. Hollick, C. Horton-Smith: "The Rôle of the Environment in Animal Locomotion" (Symposium: Section D).

Dr. S. W. Wooldridge, Dr. R. E. Dickinson, R. O. Buchanan, Miss H. G. Wanklyn, Prof. C. Daryll Forde: "Some Aspects of the Regional Concept" (Discussion: Section E).

Prof. C. E. Inglis, F.R.S., Dr. F. H. Todd, Major B. C. Carter: "Vibration" (Symposium: Section G).

Dr. K. M. Smith, F.R.S. and W. D. MacClement, Dr. R. N. Salaman, F.R.S., F. C. Bawden, Dr. R. W. G. Dennis: "Present Aspects of Plant Virus Research" (Discussion: Section K).

Prof. R. Rae, Prof. F. A. E. Crew, Dr. E. L. Taylor, Dr. J. Hammond, F.R.S.: "The Practical Problems of Animal Husbandry" (Discussion: Section M).

At 11 a.m.—R. C. Steel, Dr. P. B. Ballard, Dr. S. J. F. Philpott and Miss L. M. Holt: "The Educational Significance of the Cinema and Wireless" (Joint Discussion: Sections J and L).

At 2 p.m.—A. M. Hocart, Mrs. N. K. Chadwick, Prof. S. H. Hooke and Prof. H. J. Rose: "Ritual" (Symposium: Section H).

At 8.30 p.m.—The Scientific Delegation to India, 1937–38. Short lectures by delegates.

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

LECTURER IN PRACTICAL MATHEMATICS AND PHYSICS in the Heanor Mining and Technical School—Mr. H. C. Preston, 30, Mansfield Road, Heanor (August 22).

INSTRUCTOR IN HORTICULTURE in the University of Leeds—The Registrar (August 31).

LECTURER IN MECHANICAL ENGINEERING in the Rutherford Technical College—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne, 2 (September 2).

SCIENTIFIC OFFICERS and JUNIOR SCIENTIFIC OFFICERS in the Admiralty Scientific Pool—The Secretary of the Admiralty (C.E. Branch) (Sept. 2. Quote Ref. *C.E.* 6509/38).

TWO NATURALISTS in the Fisheries Department of the Ministry of Agriculture and Fisheries—The Secretary, 10 Whitehall Place, S.W.1 (September 5).

SENIOR PROFESSIONAL OFFICERS: (1) PHYSIOLOGY, (2) BIOCHEMISTRY in the Department of Agriculture and Forestry of the Union of South Africa—The High Commissioner, South Africa House, Trafalgar Square, London, W.C.2 (September 12).

UNIVERSITY PROFESSOR OF RADIOLOGY at the Royal Cancer Hospital—The Academic Registrar, University of London, Senate House, W.C.1 (September 20).

LECTURER IN PSYCHOLOGY in the University of Glasgow—The Secretary of the University Court.

READER IN THEORETICAL PHYSICS in the University of Liverpool—The Registrar.

Reports and other Publications

(not included in the monthly Books Supplement)

Great Britain and Ireland

Regulations for Earthing Electrical Installations to Metal Water-Pipes and Water Mains. Pp. 6. (London: Institution of Civil Engineers.) 6*d*. [38

City of Leicester Museum and Art Gallery. Thirty-fourth Report to the City Council, 1st April 1937 to 31st March 1938. Pp. 32+4 plates. (Leicester: Museum and Art Gallery.) [38

Family Allowances. By Marjorie E. Green. Pp. 32. (London: Family Endowment Society.) 6*d*. [38

Other Countries

Sveriges Geologiska Undersökning. Ser. C, No. 408: Sjösediment från Rogenområdet i Härjedalen. Av G. Lundquist. Pp. 90+4 plates. 2.00 kr. Ser. C, No. 409: Kvartsiter, sandstenar och tektonik inom Sunneområdet i Jämtland. Av Per Thorslund. Pp. 30. 0.50 kr. Ser. C, No. 410: Über die regionale Limnologie von Südschweden. Von Sven Thunmark. Pp. 160. 3.00 kr. Ser. C, No. 411: Die Svinesund-Kosterfjord-Überschiebung; ein Beitrag zur postgranitischen tektonischen Geschichte des nördlichen Bohuslän. Von Walter Larsson. Pp. 32. 1.00 kr. Ser. C, No. 412: Upplysningar till en karta över den gotländska åkerjordens fosfathalt. Av O. Arrhenius. Pp. 15. 2.00 kr. Ser. C, No. 413: Über Sedimentgesteine in der Leptotformation Mittelschwedens; die sogenannte "Larsboserie". Von Sven Hjelmquist. Pp. 39. 1.00 kr. Ser. C, No. 414: Klotentjärnarnas Sediment. Av G. Lundquist. Pp. 49. 1.00 kr. Årsberättelse för år 1937. Pp. 9. 0.50 kr. (Stockholm: P. A. Norstedt and Söner.) [287

Annuario della Reale Accademia d'Italia, 1934–1937. Pp. 648. (Roma: Reale Accademia d'Italia.) [287

State of Connecticut. Public Document No. 24: Sixtieth Report of the Connecticut Agricultural Experiment Station, New Haven, for the Year 1936. Pp. xii+954+16. (New Haven, Conn.: Agricultural Experiment Station.) [38